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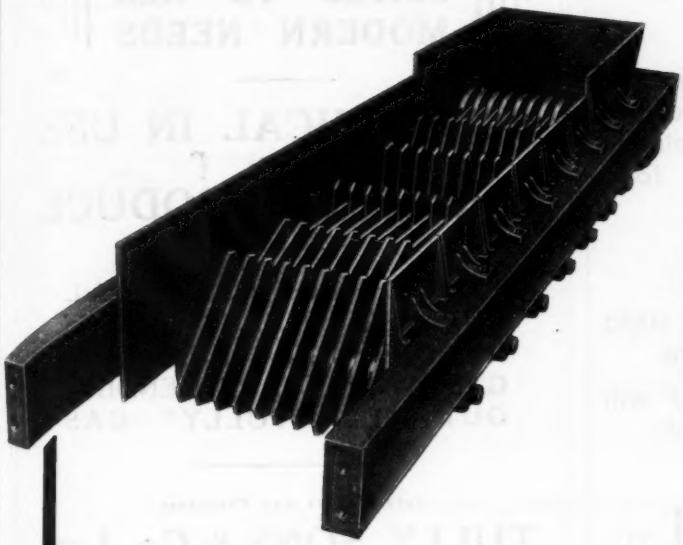

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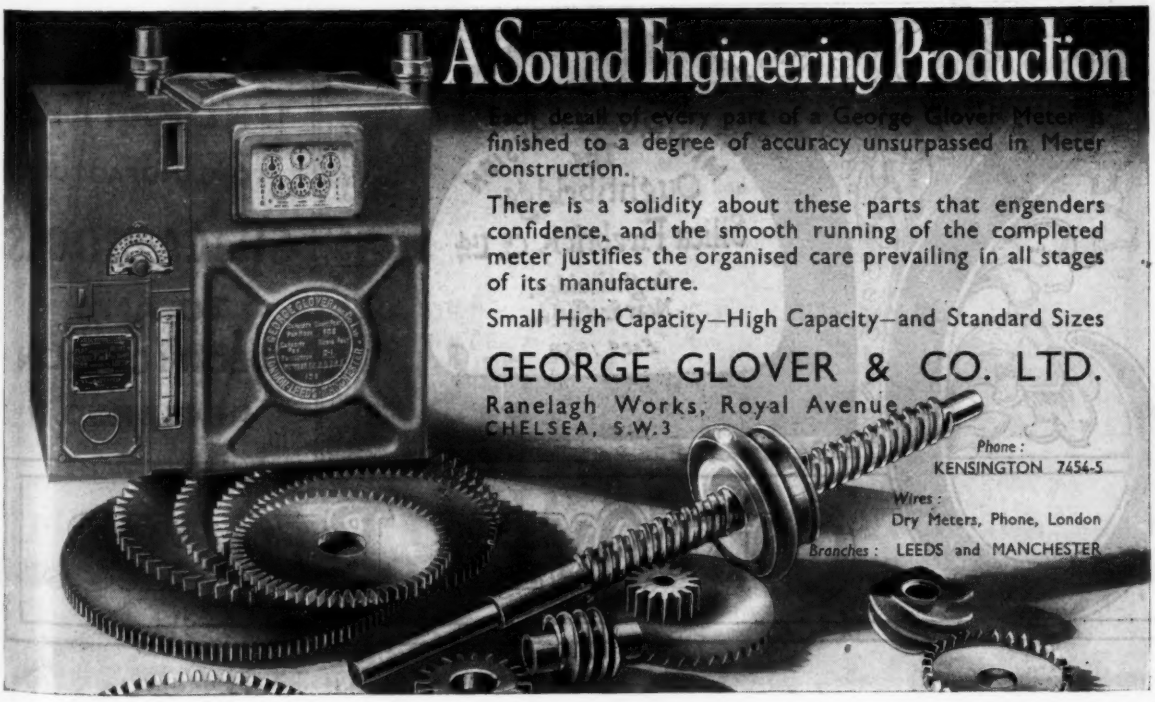

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Gas Journal

FEBRUARY 20, 1935

Vol. 209. 87th Year No. 3744.

Editorial Notes

A Products Industry

It may seem rather late in the day to remind the Gas Industry that in the process of carbonizing coal at gas-works three major products are made—gas, coke, and tar. Yet we offer no excuse for setting out this very simple statement, because it becomes increasingly obvious that the economics of gas-making demands a far broader outlook than generally obtains to-day. Responsible work during the past ten years—and the problem has been attacked from both the practical and the theoretical angle with surprisingly concordant results—has shown conclusively that cheap gas is not to be had by exclusive concentration on the make of gaseous therms per ton of coal put through a retort. The economics of gas making is governed by the interplay of the three products—gas, coke, and tar. And we hope that the closest study is being given to the oustanding contribution by Dr. Pexton which we published in the "Journal" last week, for his method of assessing gas-making results constitutes in essence a focal point in our conception of the interplay of the three major products of carbonization.

Even in the year 1935 some believe it to be a matter for congratulation when the results of a year's working show that more cubic feet of gas have been made per ton of coal carbonized than in the previous twelve months—a statement which, without qualification, is meaningless and may well represent worse, not better, management. There is only one justifiable way of judging the conduct and management of a gas undertaking, and that is to view the carbonizing process as a whole in the light of local circumstances and with an eye to public demand. "Bees in bonnets" have far too generally characterized the working of the Gas Industry, which, enjoying a flexible process, cannot afford to remain stereotyped. Make of gas per ton of coal is a typical bee which still buzzes right merrily to the detriment of the revenue account. Another bee of more recent birth but with more than two "z's" in its buzz is "maximum throughput." "High makes," "maximum throughputs," are merely confounding the issue, which is to obtain *best* makes and *best* throughputs. A platitude, perhaps? Well, it is a fundamental consideration all too frequently ignored.

Best Throughputs

Still another bee is "net coal cost per ton of coal carbonized." Fresh in our memory is the far-seeing and forceful Presidential Address of Mr. George Braidwood to the Waverley Association of Gas Managers in 1933, which was published in the "Journal" for June 28 of that year. In making financial calculations, he urged, the gas figures used must be in therms, and "thinking in results per ton should be avoided like the plague." Mr. Braidwood suggested that Scottish gas engineers operating continuous vertical retorts should abandon the idea of minimum coal throughput and maximum gas per ton and give a trial to maximum coal throughput methods instead, paying particular attention to smokeless fuel production and quality and net cost of coal. "By this method of carbonization of Scottish coals in vertical retorts," he observed, "gas of higher thermal concentration can be manufactured with ease, and that dread, under which many of the maximum gas yield engineers live, of being unable to maintain their declared calorific values is removed." We wish that Mr. Braidwood had spoken of *best* throughput instead of maximum throughput, for it is apparent that his throughput at Coatbridge is well suited to the particular conditions.

We call attention to Mr. Braidwood's practice at Coatbridge because it provides a link with the conception of the gas-making process set out by Dr. Pexton in our columns last week. Mr. Braidwood speaks of "high thermal concentration," which in fact tallies with Dr. Pexton's hydrocarbon enrichment value. It would be extremely interesting to know what the hydrocarbon enrichment value actually is at Coatbridge, whether it is an optimum or indicates under-cracking. But the all-important point—and we cannot stress this too strongly—is that both Mr. Braidwood and Dr. Pexton are visualizing the carbonizing process as a whole, realizing that the Gas Industry is a products industry.

In 1933 Mr. Braidwood was selling 19 gallons of tar per ton of coal carbonized and over 9 cwt. of coke, and he maintained that the market for a satisfactory free-burning smokeless fuel was so good that he could easily dispose of three times as much coke as he manufactured. This is something to bear in mind.

The Coke Market

In recent issues we have discussed the market for gas-works tar, with particular reference to creosote and pitch. Let us turn now to the coke market, which, until recent years, was so badly neglected. No one, we think, will deny there is a growing demand for smokeless fuel for the open firegrate; and at least one open firegrate consuming solid fuel will, we suggest, be found in the average home of this country for years to come. There are two methods of attacking the problem as far as gas-works coke is concerned. The first is the installation of special grates, fitted with gas ignition, for burning what may be termed " ordinary " gas-works coke; the second is the marketing of a coke which will burn satisfactorily in the normal grate used for coal. And in regard to the whole problem we suggest study of the recently published book on " The Solid Products of Carbonization " by the South Metropolitan Gas Company, in conjunction with Dr. Pexton's method of assessing gas-making results. The South Metropolitan Gas Company was, of course, early in the field in its endeavours to produce by carbonization a smokeless fuel acceptable from all points of view to the domestic consumer. The Company also acted as a pioneer in the development of the " Metro " coke grate, which has led to the manufacture of other models which have enormously extended the sale of high-temperature coke for room heating. Many undertakings are now offering to their consumers attractive hire-purchase terms for the " installation " of coke-burning grates, and many thousands are being installed annually. It would be highly unfortunate, however, if the very success of these grates retarded the production of still more satisfactory smokeless fuel by gas undertakings or resulted in a false sense of security. The manufacture of more suitable cokes by high-temperature carbonization will, we suggest, lead to better all-round carbonizing results and a cheaper gaseous therm.

The book published by the South Metropolitan Gas Company records the main results of a decade's work in the laboratories of the Company on the production of smokeless fuel, and some important conclusions are set out. One is that " a carbonized solid fuel to be used in the place of coal in existing open fires must be produced at temperatures below 700° C." This, it will be admitted, is a very sweeping statement. It is in regard to the desirable properties of coke for burning in special grates, however, to which we call particular attention.

Volatile Therms in Coke

We quote the following passage from the book: " The experimental work on the combustion of coke in the Metro coke fire has shown that excessive moisture in the coke was disadvantageous, but, owing to the possible dust nuisance from very dry coke, about 3% of moisture seemed desirable. The ease of ignition was mainly dependent on the volatile therm content of the coke and for coke to give satisfaction to users a minimum volatile therm content of 2½ therms per ton (as determined by the Company's test) was essential. Once ignition had been effected the volatile therm content played little part in the subsequent behaviour of the fire, the vigour of combustion then being determined by a property of the ash. This property could be expressed as the ash volume of the coke and was governed mainly by the distribution of the ash in the coal as carbonized. Shale was troublesome owing to its liability to explode if moist. The size of the coke affected its behaviour on the fire, but provided coke of 2 in.-1 in. in size were used, variations normally experienced within the limits of the grade were of little importance." In arriving at the conclusion concerning the volatile therm content of coke, it is stated that a large number of cokes from various sources were examined. It would have been much more helpful if, in setting out the results, this variety had been elaborated, and if the actual sources and conditions of manufacture had been given. There is no question, for example, that the properties of coke made in continuous vertical retorts are in many respects very different from horizontal retort cokes, and that the popularity of the continuous vertical retort owes a great deal to the peculiar properties of the coke made—properties dependent perhaps on the physical conditions of a dynamic as distinct from a static charge, apart from thermal considerations. And we are led to ask whether the South Metropolitan Gas Company lay it down as a maxim that vertical coke, for ease of ignition, must contain a minimum volatile therm content of 2½ therms per ton.

Over-Carbonizing

However this insistence on the 2½ volatile therms is most interesting, and, we believe, fundamental. There has been far too great a squeezing of the coke for the last few therms of gas. In his Cantor Lectures at the Royal Society of Arts in 1924 Mr. E. V. Evans made it abundantly clear at what expense in fuel for carbonization these few extra gaseous therms are obtained during the end period of carbonization; and the effect of the final squeeze on the throughput of plant is obvious enough. There is, we suggest, at the present time too much of a tendency to over-carbonize, and that this over-carbonization is wasteful from the viewpoints of gas production, coke production, and tar production. There is, in fact, the need for clearer notions of the economics of the carbonizing process as a whole.

We want to focus attention on the fact that there is a demand for a suitable smokeless fuel far greater than is imagined by many in the Gas Industry. As an example of this demand we refer again to Mr. Braidwood's experience at Coatbridge, where, as we have stated, he could dispose of much more coke. This coke, we may mention, contained a considerable amount of volatile matter.

The Gas Industry has an admirable opportunity in the matter of coke sales, and this opportunity demands greater efforts to market cokes more acceptable to the domestic consumer. In the foregoing we have concentrated on the use of coke in the open firegrate, because the domestic hot water boiler presents fewer difficulties. But in this direction, too, there is need for much more care, particularly in ensuring uniformity of supply. And as for the supply itself, the South Metropolitan Gas Company maintains that, as in the case of the coke fire, a minimum volatile therm content of 2½ therms per ton is essential for the coke to give reasonable service in the domestic boiler. Indeed, South Metropolitan consumers " whose requirements are particularly exacting " may purchase a special product made from a low ash coal and having a volatile therm content of not less than 4 therms per ton.

The Stockholders' Part

Not long ago—on Nov. 21 to be exact—we published a letter containing a plea that the Gas Industry should enlist, to a much larger extent than it does at present, the co-operation of its great army of stockholders. The writer of the letter suggested that if gas company proprietors, numbering almost certainly more than 100,000 individuals, were in the first place properly instructed on the subject, and, secondly, brought to realize

the fact that they can by their own efforts serve their own interests, a very important step forward would be achieved at a very low cost. Commenting on the subject, we called attention to the excellent efforts made by some gas undertakings to make their shareholders gas-minded, instancing such year books as that issued by the Newcastle and Gateshead Gas Company, the first part of which is occupied by the report of the Directors and an account of the proceedings at the annual general meeting, and the rest by propaganda material of such high standard that it can hardly fail to make shareholders enthusiastic for their Undertaking, apart altogether from the dividends which it pays them.

Such a production may be beyond the scope of the smaller gas companies, though we think that many more would find a scheme of this kind to be money well spent, provided the literature was of a really high standard. But in any case there are other ways and means of emphasizing to proprietors how much they can do in many small ways to advance the prosperity of their property, and at no season are better opportunities presented than at the dividend and company meetings season which is with us at present. At the Gas Light and Coke Company meeting the Governor said: "I should like to take this opportunity to make a special appeal to the consumers to visit our showrooms and see what we can do for them. While making this appeal to the consumers I should also like to make a special appeal to the shareholders, who must of necessity have the interests of the Company at heart, to use all their influence in their own and their friends' homes and businesses to see that they are well furnished with gas, a task in which the Company's officials will be only too glad to assist them."

This is the note we should like to see emphasized in every Chairman's speech—the idea that every shareholder can quietly do his, or her, bit towards the prosperity of the undertaking in co-operation with the whole-time officials. It must be made clear to them again and again that their own interests demand it, and we do suggest that in some way or other it must be impressed upon them exactly what services they, as proprietors of a gas undertaking, can offer to the public. We feel bound to agree with the writer of the letter to which we have referred above that "there must be many thousands of gas stockholders who do not themselves yet know of many of the uses—refrigeration and garage and greenhouse heating for examples—to which gas may profitably be put." We ourselves would place the average of intelligence still lower, and include the humble poker, and certainly the gas switch, greatly as we desire also the heavier loads.

Gas-Conscious Throughout

All of which leads us to the even more serious indictment this week by our contributor "Quidnunc," who considers it well worth while asking ourselves whether the Industry *as a whole* is sufficiently gas-minded. He has it all worked out that one man in every twenty of the whole population gains his livelihood from the Gas Industry or its ancillary trades. Some may like to argue the point with "Quidnunc;" we do not propose to do so. But even supposing the authority he quotes is one hundred per cent. wrong, and that the number is only one in forty, we still maintain that gas would be getting a far better showing than it does to-day if only one-quarter of its dependants were pulling their weight among their forty neighbours each. Add to them our 100,000 shareholders, and we should indeed have a powerful force working to swing public opinion.

So, having determined, at this season especially, to make our stockholders work for themselves, let us try some further special effort to engender among our staffs and employees active propaganda on behalf of the Industry from which they draw their livelihood, and to increase activity where such already exists. There are gas undertakings, we know, which successfully run schemes for paying commission to any employee, works or otherwise, who "introduces" business. Others do not favour such a system, but there is no reason why we should not all take every opportunity, in season and out, on the works or at staff conferences, of impressing upon every employee that his prosperity is entirely bound up with that of the undertaking and the Industry he serves. And in this respect the man who makes gas has one great advantage over the workers engaged in thousands of other trades; each one of his friends is a potential daily customer.

We do not question in the very slightest degree the loyalty of our team, which has for long enough been the envy of almost every other industry. But it is for something more active, more aggressive, that we are appealing, something which that very loyalty would willingly give if its importance was more generally appreciated. Neither have we any desire to preach to the converted, and we fully realize that many managements do work on the lines we have indicated, and give their staffs every encouragement—including the necessary knowledge—to carry on the mission. But still we are not pulling the full weight of our one in twenty, or whatever figure it may be; and we maintain that it would be good for all of us if we did.

Forthcoming Engagements

February.

21.—S.B.G.I.—Council Meeting, 2.30 p.m.

26.—Southern Association (Eastern District).—Meeting at 28, Grosvenor Gardens, S.W. 1, 2.30 p.m.

March.

7.—Midland Junior Association.—Meeting and Paper by Mr. L. W. Hathaway.

9.—Scottish Junior Association.—Joint Visit to Mining Department, Heriot-Watt College, Edinburgh. Paper by Prof. H. Briggs.

14.—Midland Association.—Meeting at Grand Hotel, Birmingham. Presidential Address of Mr. A. Roberts, of Hereford.

15.—London and Southern Junior Association.—Meeting and Paper by Dr. F. J. Eaton.

16.—Wales and Monmouthshire Junior Association.—Meeting at Newport. Paper by Messrs. H. Canning, Jnr., and J. Wilson.

16.—Western Junior Association.—Meeting at Bath.

20.—Manchester and District Junior Association and Yorkshire Junior Association.—Joint Visit to Sheffield.

20.—B.C.G.A.—Meeting of Executive Committee, 11 a.m.; Special Meeting of General Committee, 2.30 p.m.

23.—Scottish Junior Association (Western District).—Annual Business Meeting. Paper by Mr. J. L. Crossley.

April.

4.—B.C.G.A.—Eastern District Meeting, Peterborough.

4.—Midland Junior Association.—Meeting and paper by Mr. F. H. Lesley.

5.—North British Association.—Spring Meeting at Dunfermline.

5.—B.C.G.A.—Annual Meeting of Gas Salesmen's Circles, Caxton Hall, S.W. 1.

6.—Manchester and District Junior Association.—Meeting at Manchester. Paper by Mr. H. Partington.

6.—Scottish Junior Association (Eastern District).—Visit to Kirkcaldy. Paper by Mr. J. M. Dow.

Correspondence

Burden of Rates

SIR,—Your article drawing attention to the importance to all Public Utility Undertakings of the decision in a recent Appeal by the Southern Railway Company against their assessment of £2,180,000 by the Railway Assessment Authority is most opportune. The Authority, constituted under the Railway (Valuation for Rating) Act, 1930, comprises ten members, of which six appointed by the Lord Chancellor are representatives of Local Authorities. The result of the Appeal is a reduction of their assessment to £1,077,131. This being in the nature of a test case, no doubt the other Railway Companies will take steps to obtain much needed similar reductions in their assessments.

Since the passing of the Rating and Valuation Act, 1925, gas companies, like railways, waterworks, canals, harbours, mines, &c., are valued on the profit basis, unless in the words of Lord Cave " there are special circumstances sufficient to make it necessary to exclude the recognized formula of assessment and to resort to some other principle."

I venture to urge that so far as gas companies are concerned, there are cogent reasons to resort to some other more simple method than the present one, which leads to expensive litigation, often inflicts great injustice, especially on the smaller Undertakings which are unabie to contest excessive assessments in consequence of the costs of an Appeal, and entails needless expense.

I find on reference to the last published Analysis of Gas Companies' Accounts glaring anomalies in the amount charged for rates. In some instances the charge is no less than seven times that of others, and the percentage on the cost of gas varies from 13·2 to 4·5, which indicates wide variations.

I remember that, many years ago, the late Sir George Livesey pleaded for a simpler plan for assessments of gas companies to replace the present cumbersome method, which introduces the mischievous hypothetical or imaginary tenant with all the intricacies and complications of tenants' capital, adequate maintenance of the hereditaments, structural value, statutable deductions, &c., all of which involves no end of costs and labour on which there is considerable divergence of opinion, often with expensive litigation.

When will the Gas Industry realize that a simpler method of assessment is long over due?

Why cannot gas companies be assessed on a 5 years' average of their divisible profits by taking a percentage of these profits?

Public utility companies are taxed out of all proportion to other industries, and are subject to strenuous competition.

Yours, &c.,
J. FERGUSON BELL,
Managing Director.

Derby Gas Light and Coke Company,
Friar Gate, Derby,
Feb. 15, 1935.

Thio-Bacterial Action in Purifiers

SIR,—I was particularly interested in the article appearing in last week's issue of the " GAS JOURNAL " entitled " Thio-Bacterial Action in Purifiers," by Mr. W. F. Thorne.

During the summer months of the last two years several instances were brought to my notice of the appearance of H_2S in the gas on the outlet of the last box in the series, although clean gas was being admitted to the box in question.

My investigations have chiefly concerned the oxide supplied by my Company—viz., Natural British Purifying Material, consisting of quarried rich hydrated oxide of iron lightened by the addition of bog ore, and North-East Dutch Bog Ore. In general it was noticed that clean gas became contaminated during its passage through the last box on either hot or warm and damp days, but that the irregularity was not apparent during cold frosty weather. In one instance it was found that traces of H_2S were only given off when the gas temperature exceeded 65° F. The writer has had previous experience of the appearance of H_2S in gasholders, due to bacteriological action, in which connection a similar state of affairs was observed. Furthermore only new oxide was proved to be capable of giving this trouble, and in the case of the British material, when the oxide was emptied from the purifier and then mixed with partly spent material, no further trouble was experienced.

This condition was studied in the laboratory in a similar method to that described by Mr. Thorne—*i.e.*, a few drops of CS_2 were added to the two oxides under test—viz., Dutch Bog Ore and Natural British Purifying Material. The flasks containing the oxides were left on the laboratory bench—*i.e.*, in daylight—and the prevailing temperature was approximately 56° F. By the following day, in both cases a black stain was found on the lead acetate papers which had been secured in the necks of the flasks. This test was repeated, but a few drops of dilute ammonium hydrate were added, and only a very slight stain was apparent on the lead acetate paper after a week. It would therefore seem evident that if it is possible for a trace of ammonia to get forward to the box in question, the bacteriological reaction may be greatly retarded, if not altogether prevented. This is not possible practically, however, since it would necessitate the admission of a considerable quantity of ammonia with the gas on the inlet to the purifier, which would give rise to other undesirable reactions Furthermore, if a drop of CS_2 is mixed with a few cubic centimetres of even dilute ammonia in a flask, a lead acetate paper will be stained in the space of a few hours, no increase of temperature being necessary, due no doubt to the reaction

$$2NH_3 + CS_2 = H_2S + NH_4SCN$$

However, as intimated above, when new oxide (containing alkali) is mixed with partly spent material, the alkali of the new liberates ammonia from the partly spent material, which is sufficient to prevent dissociation of CS_2 by bacteria. The reason for this is clear, since bacteria to operate require the presence of humus. Humus has a great affinity for ammonia; therefore, once sufficient ammonia is admitted to satisfy the humus present, the bacteria are powerless to accomplish their fateful work.

Hence yet another advantage to those already apparent of the regular rotation of the boxes is that when a box of new oxide is found to be giving off traces of H_2S, by bringing that box into the first position, allowing it to absorb the trace of ammonia which is admitted with the gas stream, the trouble will be overcome.

Yours, &c.,
E. W. SHARMAN,
Technical Manager.

The British Gas Purifying Materials Company, Ltd.,
99, London Road, Leicester,
Feb. 16, 1935.

Art in Window Display

SIR,—The problem of window display, which has been dealt with in your columns recently, interests me greatly.

As one who is unable to attend the class at the Westminster School of Art, about which Mr. Kirkland Jamieson writes, I should welcome a fuller and more detailed exposition of the theory and practice of window display.

I may be quite wrong, but, speaking as a practical man, I find it difficult to see the value of lectures on Art Theory to people whose job it is to dress windows with gas appliances.

At the same time, I feel far from satisfied with my own efforts in that direction, and would be most grateful for any suggestions that Mr. Jamieson would care to make.

Yours, &c.,
" PROVINCIAL DEALER."

Feb. 16, 1935.

GAS LEGISLATION

A Summary of the Position at the end of 1934

By George Evetts, M.Inst.C.E., M.Inst.Gas E., M.Inst.Cons.E.

The striking articles which Mr. Evetts contributed to the " JOURNAL " at the end of last year are now available in the form of a handy book, in similar style to the very popular annual " Technical Signpost " to the " JOURNAL." A general index and marginal annotations make reference easy, and from the many inquiries received while the articles were running, we believe the publication will find a very general welcome from Boards of Directors, Company Secretaries, Municipal Officers, and in many other quarters.

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Personal

Mr. J. L. THOMSON, of the Hawick Gas Light Company, has been appointed Distribution Superintendent to the Gas Department of Kilmarnock Corporation.

* * *

At Stalybridge on Feb. 7 Mr. S. SIDEBOTTOM, who has been Works Foreman to the Stalybridge Corporation Gas Department for the last 18 years, was the guest of honour for the purpose of receiving a presentation gold watch. Alderman J. W. Greenwood, J.P., Chairman of the Gas-Works Committee, supported by the Vice-Chairman and eight other members, was present, as also was Mr. W. Hill, the former Engineer and Manager. Mr. C. Wood (Chief Clerk to the Department) was in the Chair and Mr. R. J. Restall (the Engineer and Manager) made the presentation and also expressed his appreciation of Mr. Sidebottom's services.

Alderman Greenwood on behalf of the Corporation expressed his thanks to a most loyal and conscientious worker.

Obituary

We regret to announce the sudden death, on Feb. 3, of Mr. H. R. S. WILLIAMS, Engineer and Manager of the Altrincham Gas Company, at the age of 57. Mr. Williams was well-known in the North of England. He had been Manager of the Altrincham Undertaking for about 22 years, and had previously held a similar appointment at Tyldesley. A man of outstanding ability, he had given valuable service to the Company, and under his direction there had been considerable developments and extensions of the Works, which more than doubled in size and capacity under his management.

The high esteem in which Mr. Williams was held was shown about three weeks ago when he was the recipient of a gold fountain pen from the staff and employees of the Altrincham Gas Company.

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The death has occurred after a long illness at his home, Cedar House, Hampton Wick, of Mr. WILLIAM COMLEY LAMB, who was for many years Secretary to the Hampton Court Gas Company. He was aged 72.

* * *

The death took place last week after a short illness of Councillor W. J. HARVEY, D.L., one of Edinburgh's leading public men and former Convener of the Gas Committee, in which he evinced a very keen and business-like interest. His good work in that connection ultimately led to his being appointed the Chairman of the Scottish Gas Employers' Federation. Councillor Harvey was an excellent public speaker and endowed with a remarkably retentive memory.

* * *

The death is announced of Councillor JOHN NEILL, of Bangor, Co. Down. He was Chairman of the Bangor Gas Committee for several years.

National Gas Council

Meeting of the Central Executive Board

A meeting of the Central Executive Board of the National Gas Council was held at 28, Grosvenor Gardens, London, S.W. 1, on Tuesday, Feb. 12, at 2.30 p.m. In the absence of the President, the Chair was taken by Councillor G. H. KITSON (Vice-Chairman).

The late Mr. A. Caddick.—The Chairman referred with regret to the loss sustained by the Council in the death of Mr. Caddick, late Engineer to the Croydon Gas Company. Mr. Caddick had been a member of the Board from 1919 until his resignation in 1927. A vote of sympathy with his relatives was passed, all the members standing in silence.

Before proceeding with the business of the meeting, Mr. C. Valon Bennett, President of the Institution of Gas Engineers, congratulated the Chairman on behalf of the Board upon two important appointments that he had recently received. One of these was the position of Chairman of the Coal, Gas, and Fuel Industries (Livesey Professorship) Committee, in succession to the late Dr. C. F. Tetley, and the other was the Presidency of the Leeds Chamber of Commerce.

Electricity (Supply) Bill.—The position with regard to this Government Measure was reported.

Housing Bill.—It was reported that this was a comprehensive Bill, the primary objects of which were: (*a*) To permit of the redevelopment of large areas in which housing conditions were unsuited to modern standards; (*b*) to define "standards" of housing, and (*c*) to provide accommodation of the prescribed "standards" at rents within the means of those for whom such accommodation was designed.

There were a certain number of questions which affected gas, water, and electricity undertakings alike, and it was stated that the Conjoint Conference of Public Utility Associations had decided to put forward amendments to deal with those questions.

It was also stated that it might be found necessary to move some specific amendments relating to gas alone, and glaring instances were given where Local Authorities were still endeavouring to handicap gas undertakings by prohibiting or preventing them from laying services to or carcassing council houses in the course of construction.

Housing (Scotland) Bill.—It was reported that this Bill was very similar to the English Bill, and the Council had suggested to the Secretary of the Scottish Board that there should be like co-operation between the Gas, Electricity, and Water Interests in Scotland as existed in England with regard to this matter.

Meeting of the Joint Co-ordinating Committee on Feb. 5.—It was reported that at the meeting of the Joint Co-ordinating Committee of the National Bodies held on Feb. 5 the following matters had been discussed:

(*a*) *British Gas Federation:* The first meeting of the Council of the British Gas Federation had been held on Jan. 16, and the following matters had been considered:

(i.) *Draft Constitution:* It was reported that this had been accepted by the National Gas Council, the British Commercial Gas Association, and the Society of British Gas Industries, and had been remitted to the Council of the Institution of Gas Engineers.

(ii.) *Application of the Gas Companies' Protection Association to be Admitted to Membership:* It had been agreed that the Association should be admitted to membership.

(iii.) *Representation of the National Bodies upon the Council of the Federation:* It had been arranged that each member body should be asked to nominate five representatives.

The Board approved the nomination of the National Gas Council representatives as follows:

Sir David Milne-Watson, LL.D., D.L.
Mr. A. W. Smith, F.C.I.S.
Mr. T. P. Ridley, F.C.I.S.
Mr. Wm. Cash, F.G.A., J.P., and
Mr. C. S. Shapley, M.I.Mech.E., M.Inst.Gas E.

(iv.) *Exhibitions:* A Committee had been appointed to consider various suggestions with regard to the participation of the Gas Industry in exhibitions throughout the country, and this Committee would meet on Feb. 20.

(v.) *Issue of a Periodical Brochure to Councillors and Members of Gas Committees:* It was suggested that a quarterly brochure might be addressed to members of Gas Committees and Directors of Gas Companies, indicating the position in which the Gas Industry stood in connection with Parliament and its competitors, and also as to the value of gas as compared with other forms of energy for meeting the needs of the general public and industry in general.

(vi.) *Second Annual Dinner of the Federation:* It had been tentatively arranged that the second Annual Dinner should take place in London on Monday, Nov. 4, 1935.

(*b*) *Gas Charges—Draft Brochure:* It was reported that a brochure prepared by the Officers relating to methods of charge alternative to the flat rate had been approved by the Joint Co-ordinating Committee.

It was decided by the Central Executive Board that the brochure in question should next be submitted to the Sub-Committee of the Council which dealt with questions of charge, and thereafter approved by the Board before being circulated to gas undertakings.

(c) *Public Lighting:*

(i.) *Evidence before Departmental Committee by the Institution of Gas Engineers:* It was reported that evidence had been given on behalf of the Institution before the Departmental Committee on Street Lighting.

The Gas Industry were arranging to stage a practical test in a gas-lighted street.

(ii.) *Royal Jubilee Celebrations, May 6, 1935:* It was reported that the British Commercial Gas Association had circularized gas undertakings with regard to preparations for floodlighting by gas, and had also issued a small brochure with floodlighting illustrations.

Third Annual Meeting of the Conjoint Conference of Public Utility Associations on Jan. 31, 1935.—It was reported that Lord Mount Temple had been unanimously re-elected President of the Conjoint Conference, and that the three Vice-Presidents—viz., Sir David Milne-Watson, Lord Falmouth, and Mr. William Cash were also unanimously re-elected.

At a subsequent meeting of the newly-elected Council of the Conference, Mr. W. B. Woodhouse was unanimously re-elected Chairman, and Alderman Sir Albert Atkey and Mr. Stephen Lacey were re-appointed Vice-Chairmen.

News in Brief

The North British Association are holding their Spring Meeting this year at Dunfermline on April 5.

An Exhibition of gas appliances is to be held by the Bathgate Gas Company from Feb. 26 to March 1, inclusive. Cookery demonstrations are to be given twice daily during the exhibition.

An Extension of Limits is one of the objects of a Special Order Application, under the Gas Undertakings Acts, 1920 to 1934, to the Board of Trade by the Biggleswade and District Gas Company, Ltd.

Well Known to Many Engineers in the Gas Industry, Mr. B. Newman, a foreman retort setter in the employ of Messrs. F. C. Sugden & Co., Ltd., of Leeds, suddenly collapsed and died recently while on a contract at Dursley, Glos.

Application is being Made to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934, by the Luton Gas Company for a Special Order. The objects of this Order include an extension of limits to include the urban district of Ampthill.

The Contract for the installation of vertical retorts and handling plant, &c., with a carbonizing capacity of 40 tons of coal per day at the Haywards Heath District Gas Company's Works has been secured by Drake's, Ltd., Constructional Gas Engineers, Halifax, Yorks.

At the Annual Dinner of the South Wales Branch of the Institution of Mechanical Engineers, held in Cardiff on Feb. 14, the toast "Municipalities and Industries of the District" was proposed by Mr. H. D. Madden, Engineer and Manager of the Cardiff Gas Light and Coke Company.

Leven's Increased Output.—Buckhaven and Leven Gas Commissioners are considering plans for the extension of the plant, as the Works are now taxed to capacity. The Manager's report, submitted to a meeting of the Board, states that the output for January was 14½ million c.ft., an increase of half a million.

A Cruise from the sunny little island of Barbados to the "Land of the Midnight Sun" was described by Mr. J. W. Brown, of the Barbados Gas Company, in a recent issue of the *Barbados Advocate*. An interesting feature of the cruise was a visit to Reykjavik—the most northerly town and Gas-Works in the World.

An Interesting Lecture entitled "The Romance of a Lump of Coal" was recently delivered by Mr. W. T. Dunn, M.I.Mech.E., formerly Secretary to the Institution of Gas Engineers, to a large audience on Wednesday, Feb. 13. The lecture was arranged by the Hastings and District Central Committee for the Welfare of the Unemployed.

The Floodlighting of the upper portion of the Leamington Spa Pump Room is to be continued during the months of February and March. The question of the continuance of the floodlighting after this period has been referred to the Building (Repairs) Sub-Committee of the Leamington Town Council, who have been given power to act.

A Lecture on Gas Manufacture was given by Mr. A. L. Holton, Chief Engineer, Manchester Gas Department, at a meeting of the Manchester and District Association of the Institution of Civil Engineers on Thursday last. The lecture presented two aspects of gas engineering—the varying types of coal carbonizing plants and the gaseous products obtained from them, together with the methods adopted to regulate the quality of the gas produced; and the distribution of gas to give a minimum variation in pressure at the consumers' premises.

The Great Progress made by the Reading Gas Company since 1900, together with a brief historical survey of the history of the Company since 1819, is the subject of an article in a supplement to the *Berkshire Chronicle* for Feb. 15. The supplement was published in connection with the Reading Modern Homes and Local Industries Exhibition at the Town Hall, where the Gas Company are exhibiting.

A Five Year Contract has been obtained by the Dewsbury Corporation Gas Department for the lighting of Bradford Road to class "E" specification in open competition with electricity. The Department have previously been successful in lighting the Wakefield and Earlsheaton Main Roads, and now it has also been decided to light by gas the new Savile Bridge, in course of reconstruction, over the River Calder.

Plans for a New Showroom at the Gas-Works have been approved by the Bangor Corporation. These plans involve the adaptation of the existing workshop and meter testing room by erecting another floor and generally converting it for showroom purposes. The upper floor will contain the offices and the public will have access to the showroom and offices directly from Garth Road. The Lighting Committee has resolved that specifications be prepared and that tenders be invited for the work.

Intermittent Verticals are to be installed at Milford Haven, and the Council have accepted the tender, subject to Ministry of Health approval, of W. J. Jenkins & Co., Ltd., Retford, Notts., for the new plant. The order consists of an installation with a capacity of 170,000 c.ft. per day, carbonizing North Wales coals. The bench consists of four chambers of 1·4 tons capacity each, two producers with a common producer gas flue, overhead storage bunkers for coal and coke, and automatic skip hoist for handling the material to the overhead storage bunkers.

The Staff and Employees of the Westgate and Birchington Gas and Electric Company gathered at the Nottingham Castle Hotel, Westgate, on Thursday, Feb. 7, for their annual dinner, when they were entertained by the Chairman and Directors of the Company, represented by Mr. W. H. Topley, Secretary of the Company. About fifty-five people were present. The chair was taken by Mr. B. J. King, Manager of the Company, and the health of the Chairman and Directors was proposed by Mr. E. S. Cockburn, local Secretary. Mr. Topley responded to the toast.

"Is the Expenditure on the Electrical Grid Likely to be Justified?"—This is the subject of a debate to be opened by Mr. Harold Hobson, A.M.Inst.C.E., M.I.E.E., General Manager of the Central Electricity Board, at an Informal Meeting of the members of the Institute of Fuel to be held at the British Industries House Club, Marble Arch, Oxford Street, at 6.30 for 7 p.m. on Friday, March 1. The first speaker to the opposition will be Mr. W. A. Tookey, M.Inst.C.E., M.I.Mech.E., and the Chair will be taken by Sir Alexander Walker, K.B.E.; friends of members will be welcome.

Baking by Gas.—The Leicester Gas Department anticipates that before long the whole of Leicester's baking will be done by gas. It was reported to a meeting of the Gas Committee recently that another big firm of bakers in the city had decided to change over to gas. "They are the second big firm who have changed over, and I believe that the day is not far removed when all the bakery concerns will change over to our automatic system of baking by gas," said Alderman H. Carver, Chairman of the Gas Committee. He added that 700 consumers had already taken advantage of the new two-part tariff.

The Import Duties Advisory Committee give notice of application for an increase in the import duty on ammonia (liquor and anhydrous), ammonium sulphate, ammonium sulphate nitrate, nitro-chalk, sodium nitrate of synthetic origin, and ammonium phosphate, and any mixtures thereof and any mixtures containing one or more of these products. Any representations which interested parties may desire to make in regard to these applications should be addressed in writing to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, Westminster, London, S.W. 1, not later than March 7, 1935.

Artistry in Advertising.—"The new gas building in Corporation Street is setting an example in artistic advertising. Every week their windows are different and every week they seem more attractive. Many people must have noticed the delightful display which advertised 'Alice in Wonderland' and 'Gas Fires.' The majority of those in the theatre have probably seen the gas display in our vestibule. The Gas Department do things with admirable thoroughness . . . their wares are obviously as efficient as are those people who are responsible for the sales." The above is an extract from Coventry Opera House programme.

The Tremendous Increase in gas consumption at Falkirk during the past 15 years was referred to on Feb. 12 when an exhibition of gas appliances was opened in the Town Hall by Mrs. Kennard, wife of Captain H. J. Kennard, the Convener of Falkirk Gas Department. The exhibition continued until Feb. 16. Provost Stevenson, who presided at the opening ceremony, said that Mr. H. G. Ritchie, the Engineer and Manager, had been with them for 15 years, and during that period the undertaking had increased by leaps and bounds. Through Mr. Ritchie's work they had been able to supply gas as cheaply as almost any town in Scotland.

Cookery Demonstrations arranged by the Gloucester Gas Light Company in conjunction with the Parkinson Stove Company were held in the Company's showrooms, Eastgate Street, Gloucester, from Feb. 11 to 15, and proved highly successful. The attendances at each lecture broke all previous records, and keen public interest was shown in the attractive range of modern gas appliances displayed. Miss H. Crawford-Fox, M.C.A., A.T.C.L., of the Parkinson Stove Company, demonstrated the efficiency and economy of modern gas appliances by the cooking of a dinner for four persons at a cost of less than 2d., using a Parkinson "Calthorpe" Cooker.

In Budgeting for the year 1935-36, Manchester Corporation Gas Department anticipates a capital expenditure of £38,000, including £18,000 for cast iron mains and £20,000 for meters, cookers, and fires. Income from sales of gas, including street lighting, is estimated at £1,117,600, hire of appliances, £34,000; residual products, £184,000; which, together with sundries, total the sum of £1,336,500. On the expenditure side of revenue account, outgoings by way of the cost of coal and oil, carbonization, repairs, provision for renewals, salaries, rents and rates, total £1,002,500. Interest on loans and sinking fund absorbs £188,000. A credit balance of £86,000 is anticipated.

Dundee Public Lighting

Automatic Control Vetoed

A Sub-Committee of Dundee Police and Lighting Committee decided on Feb. 13 not to entertain the idea of a £23,500 expenditure to introduce automatic controllers on the gas lighting system in the streets. The extinction of the lamps along Riverside Drive at midnight was also vetoed.

Referring to a report by Mr. R. D. Robertson, the Public Lighting Superintendent, Convener Wm. Reid said that annual loan charges over seven years for the introduction of automatic controllers would be £3,863, against which there would be a reduction in staff of eight men and a reduction in the consumption of gas. But the cost would still be £1,407 per annum.

He did not think they would suggest putting the whole gas lighting system under automatic control. A third of it would cost £7,862 or £1,287 per annum, with a saving of £818, but an annual loss of £469.

Mr. R. A. Scrymgeour said that while the automatic principle was the most modern it seemed to cost a great deal more initially than it cost to have men attending to the lights, and it would be throwing men out of employment.

Convener Reid remarked that the police were against light reduction.

Amalgamation and Grouping

Further South-Western Gas and Water Corporation Acquisitions.

We are informed by Close Brothers, Ltd., the Secretaries of the South-Western Gas and Water Corporation, Ltd., that the Corporation have acquired 100% of the 6% preference shares and 100% of the ordinary shares of the Crewkerne Gas and Coke Company.

The Corporation have also acquired 95·5% of the original shares and 86·8% of the "B" shares of the Midsomer Norton Gas and Coke Company, Ltd.

Woodall-Duckham Work in 1934

The year 1935 promises to be one of great activity in constructional work for the Woodall-Duckham Company, as the total volume of orders received during 1934 for W.-D. plants by the Company and its overseas associates, if reckoned in terms of plant capacity, has never been exceeded in any previous year.

Contracts for new installation of W.-D. continuous vertical retorts included a large installation of thirty-two 103 in. retorts for the Rome Gas Company (304 tons of coal per day); an installation of sixteen 82 in. retorts for the Liverpool Gas Company (third installation, 153 tons per day) and a similar number of retorts of the same size for the Chester United Gas Company (132 tons per day); an installation of ten 62 in. retorts for the Stourbridge Gas Department (third installation, 62 tons per day); installations of 53 in. retorts for the Exmouth Gas Company (eight retorts, 47 tons per day); for the Tunis Gas Company (fourth installation, four retorts, 20 tons per day) and the Carmarthen Gas Company (three retorts, 15 tons per day); and an installation of three 44 in. retorts, which has already for some months been at work, for the Burgess Hill and St. John's Common Gas Company (10 tons per day).

An interesting plant was also ordered by the Pecser Kokswerke A/G of Pecs, Hungary. It consists of 24 W.-D. continuous vertical retorts capable of carbonizing at medium temperatures 236 tons of coal a day, for the production of smokeless fuel.

Several important reconstruction schemes, involving the replacement of old type downwardly-heated retorts by the latest type upwardly-heated model, have been put in hand, notably at Hull (where the capacity of the new plant will be more than double that of the old), at Nottingham (Basford Works), at Greenock, at Smethwick, and at Birmingham (Coal Test Works).

New plants were successfully completed and put into operation at Birkenhead (sixteen 103 in. retorts, 165 tons per day), Nottingham (eighteen 103 in. retorts, 200 tons per day), and Neath (eight 53 in. retorts, 36 tons per day).

Installations were rebuilt and modernized at Wallasey, where a bench of 28 retorts replaced six settings of four retorts (140 tons per day), and at Swan Village Works, Birmingham, where twenty-four 62 in. upwardly-heated retorts have been built in place of sixteen retorts and capacity has been raised from 84 tons a day to 156 tons a day. A reconstruction of 16 retorts was also carried out at Ipswich.

Two orders were received for W.-D. intermittent vertical chambers from the Wandsworth and District Gas Company. One, which comprises a bench of 36 chambers (240 tons per day), is already at work, and construction has been commenced on the other, a bench of 30 similar chambers.

Two important orders were received by W.-D. Becker coke ovens and bye-product plant, one including 58 ovens for the new steelworks scheme of the British (Guest Keen Baldwins) Iron and Steel Company at Cardiff (1,214 tons of coal per day), and the other, comprising 53 ovens for the Workington Steelworks of the United Steel Companies (1,159 tons per day). Both of these plants include, *inter alia*, coal handling and coke handling and screening plant and complete bye-product and benzole recovery plants.

The W.-D. waste heat boiler continues to make progress, and fifteen boilers were ordered during the year, to work in conjunction with various types of plant. Eight of these boilers will work in conjunction with continuous vertical retorts (seven in Great Britain and one in Australia); two with intermittent vertical chambers; three with horizontal retorts (one in Great Britain and two in Australia); and two with refuse destructor furnaces.

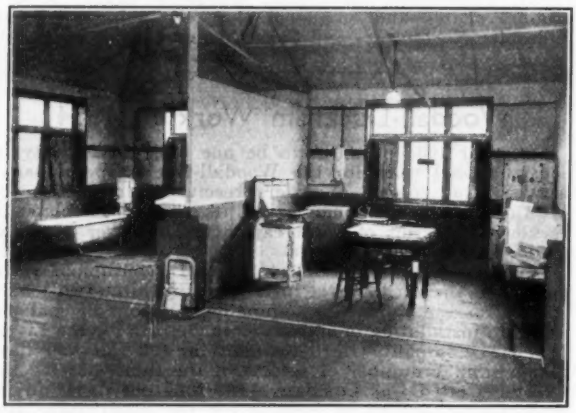
T.I.C. tar treatment plants were ordered for Katoomba (Australia) (10 tons crude tar per day), Hesselborg (Moss, Norway) (20 tons per day), and Bournemouth (Poole Gas-Works) (25-50 tons per day).

Coke screening and storage plants were ordered for Chester, Stourbridge, Liverpool, and Smethwick, and a coal

blending and storage plant for Messrs. King Coal, Ltd., at Wandsworth.

Steam raising refuse disposal plants were ordered by the Beckenham Urban District Council, by the British Brush Company (Wymondham), and by the Midland Joinery Company (Burton).

Gas Exhibition at Bude



A successful exhibition of gas appliances and cookery demonstrations were held at Bude last week. This is the first effort of its kind to be held in this Cornish seaside resort, and it attracted a great deal of attention. A large hall overlooking the sea was divided off into model rooms, appropriately furnished, and fitted with gas appliances. Attendances were far larger than expected and a well-earned bouquet was presented to the Demonstrator, Miss A. Andrew, of R. & A. Main, Ltd., at the final demonstration. The whole of the arrangements were carried out by the staff of the Bude Gas Company (which is one of the companies forming the South Western Gas and Water Corporation, Ltd.), under the supervision of the General Manager and Secretary, Mr. J. C. Cotterill, and the Works Manager, Mr. W. Selby.

Jubilee Floodlighting

B.C.G.A. Booklet

The Secretary of the 1935 Jubilee Celebrations Committee (Mr. J. R. W. Alexander) appointed by the Joint-Co-ordinating Committee of the Central Gas Organizations has provided us with a copy of "Floodlighting by Gas," a fully illustrated and informative booklet issued, at the request and with the approval of the Committee by the British Commercial Gas Association to Gas Undertakings.

Attention is drawn to the necessity for gas undertakings to act without delay if the most suitable buildings are to be secured for floodlighting and if the necessary equipment is to be delivered in time.

The Committee is prepared to advise gas undertakings in the matter, whilst the makers of gas lamps have arranged to assist gas undertakings in the drawing up of appropriate floodlighting schemes.

Co-operation with the Architect and Builder

At a meeting of local Builders and Architects, Mr. R. W. Kershaw, Distribution Manager to the Gloucester Gas Light Company read a paper on "The Effect upon Building Construction by Adopting Gas Heating."

The author emphasized the economy in capital expenditure and the gain of valuable space by installing the Nautilus cast concrete flue system for gas fires. In a typical case, he said, the estimated cost of building from the footings to the chimney pot by the ordinary brick system of flue construction is £32. The cost of building Nautilus flues, less the cost of brickwork saved in a 9-in. wall, is £5 11s. The saving therefore effected by the use of Nautilus flue blocks is £26 9s.

Assume the brick flues to have a total run of 53 ft.—that is, from the ground floor to chimney pot and first floor to chimney pot. The cost per foot for a pair of flues is approximately 12s. Assuming an overall run of 38 ft. for the Nautilus flues, the cost per foot run is approximately 3s. per pair of flues. Let us, continued Mr. Kershaw, examine the extra cost of Nautilus flues where no flues are provided. Assuming again the flues back to back on ground and first floor with a total run of 38 ft. of Nautilus double blocks.

	£	s.	d.
The total cost including building-in sets and terminals will be	6	13	0
Add for building 38 ft. run at 9d. per ft.	1	7	6
Add for lead finishing	0	3	0
	£8	3	6
Less 40 ft. cube brickwork at 1s. 4d. per cube	2	13	0
Total cost over 9 in. walling for forming 4 Nautilus flues complete	£5	10	6

Mr. Kershaw went on to detail a scheme of co-operation which the Gloucester Gas Light Company offer to builders. The above saving in construction, he explained, can be augmented by installing inset gas fires, and thus eliminating cast iron surrounds. To assist the builder the Gas Company offer certain rebates, as follows:

A credit of 2s. 6d. per lighting point to be granted where no other lighting is provided.

A credit of 5s. for installing gas ignited coke grate when approved by the Company's representative.

General.—The following schedule of credits to operate at the option of the builder:

	s.	d.	
Class "A."			
Lighting	2	6	per point
Cooker, copper, geyser, and one fire	17	0	
Class "B."			
Lighting	2	6	per point
Cooker, copper, geyser, and two fires	21	0	
Class "C."			
Lighting	2	6	per point
Cooker, copper, geyser, and three fires	25	0	

Popular Cookery Lectures at Coventry

Each Wednesday afternoon witnesses gatherings such as this in the Demonstration Hall of the Coventry Gas Department's Central Showrooms, while on Wednesday evenings lectures are given to those whose business prevents attendance during normal demonstration hours. In addition, weekly series of cookery demonstrations are held in other halls throughout the Department's area of supply, while to meet the needs of school children, cake baking competitions for those under 16 years of age are being promoted in connection with these lectures.

Rental Recording Money Box

Some Further Details.

In the "JOURNAL" for Jan. 30, we gave an illustration and some details of a recording money box in use at Stretford for the collection of service charges and we are indebted to the manufacturers, the Gas Meter Company, Ltd., who have now placed the device on the market, for the following supplementary details.

The money box is designed to be used for any purpose

where an instalment is to be collected, such as gas service rental (two-part tariff) or hire-purchase terms for appliances, and is arranged to collect and record four sixpences per month—forty-eight per annum. The construction is very neat, compact, and robust. A heavy-gauge steel outer casing forms the container for mechanism and cash. The fixing screws are concealed when the box is closed. A stout locking hasp is strongly riveted to the back and engages in a spring locking device, which, with retaining flange on box, holds the front plate firmly in position.

The whole of the mechanism is mounted on the front plate and is entirely detachable from the box; there is no hinge to go wrong. The keyway of lock is especially protected to prevent tampering.

The slot is half-masked to prevent the insertion of coin until carrier is in correct position. After insertion of coin the knob is turned anti-clockwise, operating the recorder to show the week to which instalment has been paid. The appliance is not connected to the gas supply service. The consumer has, therefore, no fear that his gas supply will be arbitrarily cut off if sixpence is not inserted on any particular night. He can pay at his convenience, and a correct record of his payments can be inspected at any time.

Manchester and District Junior Gas Association

Members of the Manchester and District Junior Gas Association visited the Victory Works of Messrs. Parkinson & Cowan, Ltd., on Feb. 6. The Works are situated in Talbot Road, Stretford. The visitors were conducted in parties over the various sections of the Works, and every opportunity was afforded to inspect the several stages of manufacturing not only gas meters, but also water meters.

The factory is well organized and mass production methods are adopted in manufacturing the various component parts, which are carefully gauged before assembly. Exhaustive tests are also carried out on the completed meters. Great interest was shown in the various intricate machines for stamping out wheels from solid brass, the cutting of teeth, stamping meter cases, &c.

After the visit, the members were conveyed to the Talbot Road Public Hall, where tea was served at the kind invitation of the Directors of the Company.

Mr. COLLINGE (Preston) proposed a vote of thanks to the Directors of the Company for their cordial welcome and kind hospitality. Mr. Collinge said that the gas consumed at the Works had constantly been increasing, from 10 million c.ft. in 1932 to 22½ millions last year. These figures indicated the progress that had been made by the Company. On going round the Works, he had been particularly impressed by the fact that the various component parts of a meter were gauged to *plus* or *minus* a thousandth part of an inch. Mr. Collinge stated that he had come to the conclusion that the measurement of the volume of gas was more carefully carried out than the measurement of the calorific value. The two principles of the Company appeared to be "accuracy" and "anticipation." They had anticipated trouble by preventing the diaphragm from cracking due to the distribution of dry gas, and where the gas was wet provision was made for condensation. In the case of water meters, provision was made to prevent damage due to the water freezing.

In conclusion, Mr. Collinge thanked the Directors of the Company, mentioning particularly the names of Colonel Woodall and Mr. H. Butterworth, and also the Works Manager, Mr. E. Butterworth, for the kindness extended to the members of the Association.

Mr. ALFRED L. HOLTON (Manchester) stated that it was a pleasure to second the vote of thanks, because one of his old colleagues of the Manchester and District Junior Gas Association was now a Director of Messrs. Parkinson & Cowan, Ltd. He referred to Mr. H. Butterworth.

The PRESIDENT (Mr. James Carr) in supporting the vote of thanks, stated that Mr. H. Butterworth had very readily agreed to consult his co-Directors when he suggested the visit. Those members who visited the Works some years ago would have noticed the great re-organization that had taken place throughout the whole of the Works.

Mr. H. BUTTERWORTH, responding to the vote, said that before leaving the Works that day Colonel Woodall had asked him to convey to the members his deep regret that he had been unable to attend the meeting that afternoon. He (the speaker) had very pleasant recollections of his early association with the Manchester Juniors.

The Works Manager, Mr. E. Butterworth, said that he was very pleased that the re-organization that had taken place at the factory had been noticed by the visitors.

Scottish Junior Gas Association

Visit to Messrs. H. Balfour & Co., Ltd., Leven

On Feb. 9 members of the Scottish Junior Gas Association (Eastern District) visited the Durie Foundry of Messrs. Henry Balfour & Co., Ltd., Leven. Mr. W. Lindsay Burns and staff met the members in the main office, and, after a word of welcome, conducted them over their works, which had been kept in operation to make the visit as informative as possible.

In the foundry, the complete operations required in casting various plates, brackets, wheels, cylinders, &c., were being performed, and the use of machine moulds and the adoption of compressed air as labour-saving devices were demonstrated. The pattern shop was visited and then the steel plate workshops. The extensive use of electric welding was a feature of the work done here, and also oxy-acetylene for cutting out holes and special shapes. An interesting machine for bending plates to any pre-determined angle showed the great advance from the old methods of hammering, both in quality of workmanship and speed of operation. The firm are specializing in the production of tanks and containers for foodstuffs, &c., and in this connection are using stainless steel. Besides stainless steel, glass-lined tanks and vessels are being increasingly used, and about a year ago, Messrs. Balfour, in association with Enamelled Metal Products Corporation (1933), Ltd., erected a complete new factory for this process. Both cast iron and steel can be lined with this glass in various colours.

A gas producer using washed doubles is employed to supply gas to a heat treatment furnace, into which the vessels to be lined with glass are put for annealing and treating. A huge travelling crane lifts the vessels from the workshops and places them on a revolving platform. This is lifted by hydraulic power into the furnace, which has a number of burners using a mixture of producer gas and air so regulated to give the desired temperature for the heat treatment.

In the fitting and turning shops, all modern types of machine tools were in operation carrying out general engineering work. Part of this building was erected in 1810 when Messrs. Henry Balfour set up business in Leven.

After the visit, the Association were entertained to tea in the Caledonian Hotel, Leven. Mr. W. Lindsay Burns said that he joined the Juniors 27 years ago and had benefited greatly by the knowledge gained during visits made when he was a member of the Association, and he urged the young members present to take advantage of all the opportunities which the Association offered. They were very pleased to have been able to bring a new industry to Scotland. The plant which they had seen was one of the most modern in the world for glass lining vessels, and he visualized a great future for it.

Mr. G. Bruce (St. Andrews), President of the North British Association of Gas Managers, congratulated Messrs. Balfour on their enterprise in building the new factory, and said that a greater degree of this spirit of adventure was needed in these times of keen competition. He said the Gas Industry had a great field for industrial and domestic uses of gas, and with a determination on the part of the personnel to win through, the Industry would go from strength to strength.

Mr. W. G. Readdie (Anstruther) said that he could speak of Messrs. Balfour from both the inside and the outside, as he had been in the firm 50 years ago. He said the new plant had created a demand for labour and now 400 employees were engaged where only 200 had been before. The original gas-works at Anstruther had been built 100 years ago by Messrs. Balfour, and their reputation for high-class materials and first-class workmanship had been maintained since that time.

Mr. C. L. W. Berglin, B.E., A.M.I.Chem.E., a member of the staff of Messrs. Balfour, then read a paper on "Producer and Water Gas Plants." Time did not permit for discussion.

In closing the meeting, Mr. Lindsay Burns said that the Industry need have no fear of electricity superseding gas if the boards of directors and others would make up their minds that they were determined to keep gas instead of visualizing its loss, and when they made a profit not to pay it away in large dividends but re-invest it in modern plant and so equip themselves the better to meet competition.

The "Supervia" Highway Lamp

Communicated by the South Metropolitan Gas Company.

The original purpose of street lighting was to increase the security of the foot passenger at night time, to assist in the policing of the street, and to mark the line of the roadway. For these purposes the most suitable position of street lamps was close to the curb dividing the footpath from the carriage-way. With increase in speeds and volume of traffic the whole problem of road illumination altered. The greatest illumination was now desired on the carriage-way instead of on the footpath and it became necessary to provide sufficient light to ensure that an object in any position on the carriage-way could be seen and recognized easily from a distance. Many conflicting views have been advanced regarding the relative importance of surface illumination and background illumination, and the controversy remains unsettled, but it cannot be gainsaid that a lighting system which produces alternate patches of light and shade on the road surface falls short of the ideal. The problem of lighting busy highways may be regarded as a specialized form of floodlighting, and it is notorious that many of the most carefully planned street lighting systems are inferior to the adventitious street lighting which is obtained by the light escaping from well-lit shops along the side of the road.

The desirability of obtaining more uniform illumination has been increasingly recognized by the Gas Industry as the nature of road traffic has changed. The earliest attempts to effect a re-distribution of light from the existing street lamps consisted in the addition of reflectors with or without an increase in the total illumination provided. This was followed by the installation of more powerful light sources mounted on higher standards, still along the curb line. With increasing realization that the intention was to illuminate the carriage-way rather than the footpath centrally suspended lights were adopted. On the grounds of cost the number of such lights per mile of road was necessarily limited, and as the roadway immediately below one of these lamps was more brilliantly lit than that portion of the road between two lamps, the intensity of illumination varied from point to point along the road.

Until recently it did not appear possible that more uniform lighting could be obtained without considerably increased expenditure. It would, for instance, have been possible to increase the number of light sources and reduce the interval between them, or it would have been possible to obtain a similar effect by increasing the power of the light sources and raising them further from the road surface. As an alternative to these admittedly expensive methods reflectors or refractors might have been incorporated in the lamp so as to re-direct the light, but it is known that all such devices result in some light absorption and consequent decrease in total amount of light available.

Attention was then directed to the possibility of altering the shape of the light source. Hitherto gas mantles had been invariably cylindrical in shape, the shape having arisen by the desire to fit the flame which issues from a burner nozzle with a round hole. There seemed, however, to be no fundamental reason why all burner nozzles should have round holes or why in consequence all mantles should be cylindrical. It is only the surface of a flame which comes in contact with the mantle and the cylindrical flame happens to be the flame shape which possesses the minimum surface. If the shape were altered in any way the surface would be increased and presumably the amount of mantle fabric which could be heated by the flame would be greater. Moreover, the increased surface could be placed in such a position that the light developed at that surface would be thrown in the direction where it was most needed.

Experiments showed these suppositions to be correct. A high-pressure gas lamp designed to develop 1,000 c.p. was modified by making the burner nozzle in the form of a slot instead of in the form of a round hole. A special mantle was then made consisting of a bag with two flat rectangular sides of greater length than depth. On test this modified lamp was found to give in a direction at right-angles to the flat surface of the mantle an illumination of 2,500 candles as against the previous figure of 1,000. The extent to which the asymmetry of a mantle can be increased is limited by the strength of the mantle material and the tendency for the pressure of the gas within the mantle to distend the bag of mantle ash, and it has not so far proved practicable to obtain all that is desired by modification of the mantle shape alone. Because the total amount of light available has been increased by increasing the mantle surface, there is less objection than formerly to the use of reflecting or refracting devices and a Holophane refractor has been introduced below the mantle to re-direct in a horizontal direction a portion of the light which would otherwise pass vertically downwards. The results of combining the two effects are shown in the polar curves from which it may be seen that in the direction where maximum illumination is required the candle power has been increased about four times without increase in gas consumption.

The Supervia lamp is at present being produced in two sizes: No. 1 with a gas consumption of 0·11 therm per hour and a maximum candle power of 4,000, and No. 2 with a gas consumption of 0·06 therm per hour and a maximum candle power of 2,200.

It has always been one of the advantages of gas lighting that the light may be dimmed at will by reducing the pressure at the burner nozzle. Hitherto with high-pressure gas lighting some difficulty has been encountered

POLAR CURVES OF LUMINOUS INTENSITY IN VERTICAL PLANE AT RIGHT ANGLES TO FLAT SURFACE OF MANTLE.

SUPERVIA No. 1 HIGH PRESSURE GAS LAMP ————

" " 2 " " " " - - - - - - - - - -

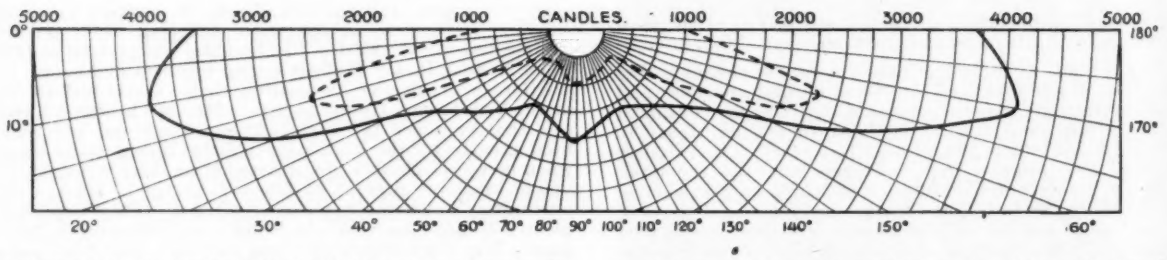
MEAN RADIAL CANDLE POWER. ———— 2202 CANDLES.

- - - - - - 1107 "

GAS CONSUMPTION PER HOUR ———— 19·2 CUBIC FEET.

- - - - - - 11·0 " "

GAS PRESSURE = 81"



because of the tendency of the flame to contract within and away from the mantle, but experience with the Supervia lamp has shown that it is possible to reduce the pressure at the nozzle from 81 in. to 30 in. W.G. when the flame still burns in contact with the mantle fabric giving about half the amount of light obtained at full pressure and consuming about half the quantity of gas. This valuable property of the Supervia lamp makes it possible to provide at the same cost increased illumination at the hours of greatest traffic and then, during the later hours of the night, to provide illumination which although reduced is still greatly in excess of that customary at present.

UNDER THE LENS

By Quidnunc

Make the Gas Industry Gas-Conscious

A shareholder in a small gas company writes asking me to air a grievance. He complains bitterly that a Director of the Company uses electric light and electrical gadgets in his own house. "In a small community like this," says my correspondent, "where everyone knows his neighbour's business, this Director's preference for electricity is well known, and it is doing a lot of damage to gas. How can you expect people to believe in the sincerity of gas advertisements when they know that a Director of their own gas company is a big user of electricity? It is like the joke in *Punch*, where the manufacturer of a patent trouser-press is shown pressing his own trousers under the mattress. If Directors are not convinced of the superiority of gas, how can you expect salesmen and other employees to be enthusiastic?"

This is probably an isolated case. Yet it is worth while to ask ourselves whether the Gas Industry as a whole is sufficiently gas-minded. A well-known gas manager recently calculated that the gas and allied industries employ nearly 4½% of the total insured male population. In other words, if we accept these figures, one man in every twenty gains his livelihood from the Gas Industry or its ancillary trades. If every one of these employees could be primed with the gas story, and made to realize the importance of his own function as a disseminator of propaganda in his own immediate circle, we should have a powerful means of swaying public opinion.

The Customer is Sometimes Wrong.

As it is, we cannot even rely on the 100,000 employees of the supply industry itself to present the case for gas in its most favourable light. This statement may shock the susceptibilities of those who are not constantly in touch with the average small householder, but a little thought will prove its truth. For most householders the Gas Industry is humanized only by occasional contacts with the gas fitter or the meter reader. To the ordinary consumer, these men are the Gas Industry. In general they have a high reputation for skill, urbanity, and careful work. Yet many of them would be stumped by the questions of an ordinary well-informed householder who had studied electrical sales literature. Others, in a praiseworthy desire to please, suffer from the habit of endorsing all the consumer's complaints. For instance, I have known a fitter sustain a consumer's preference for filling the drip-tin of her cooker with water in face of demonstrator's earnest advice to the contrary; he held that this course was necessary to absorb the "fumes." Every gas man has come across similar cases in which a consumer's complaint has been strengthened by the ready acquiescence of a fitter or maintenance man. The axiom that "the customer is always right" may work quite well in teashops or groceries; but it can be carried too far in the Gas Industry, especially in these days when house-to-house canvassers for electricity infest the streets in search of prey.

Several undertakings have faced up to this problem by issuing a simple manual to every employee. This manual contains brief and convincing answers to the most common questions asked by consumers. As these questions are often caused by aggressive electrical propaganda, it is absolutely essential that the employee should know the basis of comparative costs for various domestic purposes, and be able to demolish arguments about "fumes," meat shrinkage, and other bogeys. In addition, each employee should know the scope of his own undertaking's service to consumers, and the selling-points of the new appliances.

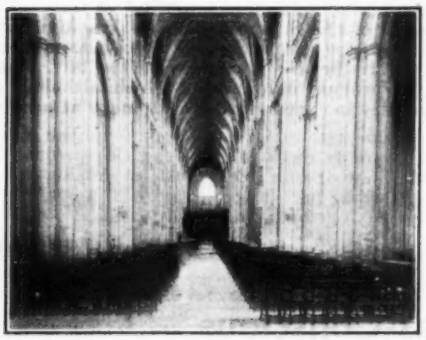
Some undertakings go further than this, and try to convert their shareholders into active propagandists for gas. This line has not been carried far enough. One of the best-argued statements for gas which I have come across was issued, not by a gas company, but by a firm of stockbrokers who foretold a flourishing future for the British Gas Industry by taking examples from other countries where gas had expanded its market in face of such electrical competition as we in this country have never encountered.

Our Enemy the Amateur.

It is not really surprising, however, that a stockbroker should champion the Gas Industry, when we remember that the most ardent partisan of electricity is not the electrical engineer but the amateur electrician. In fact, the greatest enemy of the British Gas Industry is the idealistic amateur who, having no financial interest in electricity, associates electrical development with national planning both in the political and the economic sense; who sees in electricity the agent for reviving industry, for abolishing slums, for reducing work in factories and homes, and for introducing a new standard of entertainment and pleasure. This headlong enthusiast makes up for numerical insignificance by intense activity and genuine public spirit; the type is found among Councillors, politicians, women's societies and social organizations, exerting a continuous and uncritical influence in favour of electricity. These people do not realize the national importance of the Gas Industry because they have not learned to think of the Gas Industry as a national institution. But everything has combined to give the electrical industry a spurious importance in their eyes: the rapidity with which it has been adapted to various domestic and industrial uses; the manner in which its growth has been fostered by State action, at a time when governmental interference with industry is growing steadily more popular; and the spectacular treatment it has received in the popular Press, often from political or mercenary motives. At the same time its novelty, leading to its introduction into fashionable homes, has given it a kind of snob-value; and a curious result of this is the passionate demand of certain levelling politicians that the poor should have the same household equipment as the rich, and that electricity should therefore be made available to, if not actually forced upon, the migrants from condemned slum property.

The nature and depth of public interest in gas and electricity respectively may perhaps be gauged from their treatment in our popular drama. At the time of writing, a new play is being staged in London in which attention is focussed on the all-electric equipment of a smart, up-to-date, and topically unhappy family. The only recent dramatic presentation of gas (apart from undesirable incidents in melodramatic films) was a music-hall farce in which a gas official was the leading butt and buffoon, much like the mother-in-law, the comic policeman, or the red-nosed comedian of other days.

This may seem an extravagant comparison, and no doubt it would take a great many slick electrical plays and a great many music-hall witticisms to impair the solid credit of the Gas Industry. The fact remains that if we are to create a public atmosphere favourable to gas, and to draw public attention to the immense national services, public spirit, and enlightened outlook of the Industry, we must first make members of the Industry itself more gas-conscious. Not only every employee, but every Director, every shareholder, every Councillor where an undertaking is municipally operated, must be given a true picture of the Gas Industry, of its present activities, its responsibilities, its advantages, and the scope for its extension. If every person connected with a gas undertaking can be persuaded to view the Industry as a whole, to make his own home a real show-house for gas, and to infect his immediate circle with his own enthusiasm for gas by spreading accurate information of its uses and possibilities, we shall not need to complain of electrical bias among the public.



The Nave, looking East.

CENTRAL HEATING OF WINCHESTER CATHEDRAL

Winchester Cathedral, the second largest edifice of its kind in the world, has recently had installed, with complete success, a central heating system operated by gravity feed coke boilers.

The gravity feed coke boiler is a comparatively recent development—for which the Gas Light and Coke Company and the London and Counties Coke Association have been largely responsible—and it should prove of increasing value in assisting the Gas Industry's coke sales.

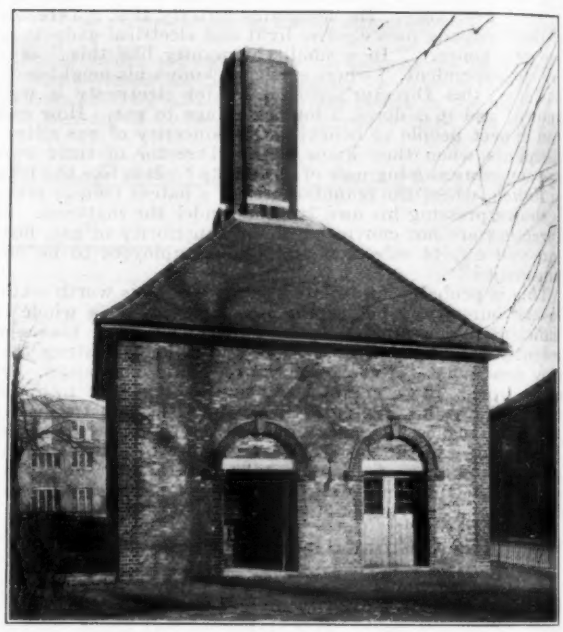
Our readers are probably familiar with the general principles of design of the gravity feed coke boiler and also with its main advantages, chief, perhaps, of which should rank its almost completely automatic operation, its high efficiency, great economy, and the fact that coke is by far the most economical and satisfactory fuel which can be used in this type of boiler.

The gravity feed coke boiler was developed in order to meet the growing demand for a boiler burning coke automatically, noiselessly, without moving parts, and which at the same time would be economical in fuel consumption, maintenance, and space. While not so completely automatic in operation as the gas boiler, this gravity feed apparatus calls for an absolute minimum of attention—one visit a day for the purpose of removing the ash and re-charging the hopper is all that is necessary, after which the whole plant may confidently be ignored. Even the ash pit may, if desired, be provided with sprays or a water tray whereby the ashes may be sluiced hydraulically into a sump. Furthermore, this boiler uses the Gas Industry's chief bye-product and a stable and national commodity.

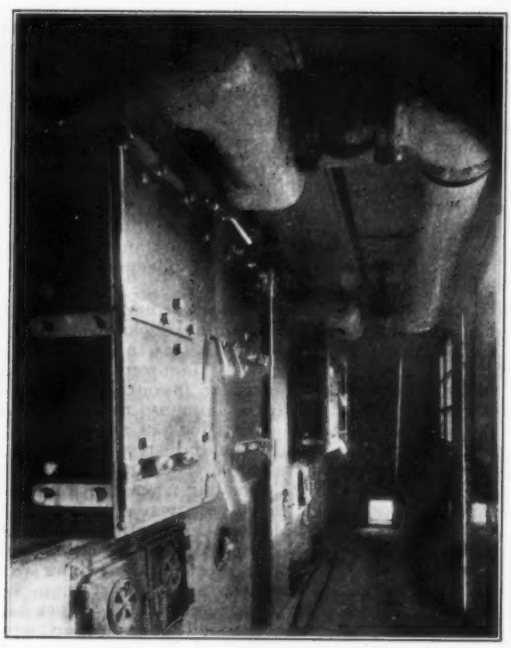
Details of the Boiler.

Boilers of this type are now made with rated outputs from 100,000 to 2,000,000 B.Th.U. per hour at a coke consumption of 4 lbs. per sq. ft. of grate area. By reason of the fact that the grate loading is kept low to avoid the formation of clinker, the boilers will, in most cases, give a 30% overload without much difficulty. Coke is charged initially into a bunker above the boiler, constructed to hold at least a week-end's supply at rated load. The boiler's individual storage hopper can then be charged very simply direct from this main bunker. From the boiler magazine the fuel falls by its own weight into the V-shaped fire-grate, so designed that the slope of each arm is at the natural angle of repose of coke, which therefore takes a position parallel to the grate and forms a firebed of even thickness. By this means uniform and efficient combustion is maintained automatically over the whole grate. The shrinkage of the burning fuel causes coke to feed from the magazine at the same rate as it is consumed. All the dampers, air controls, &c., are linked together and operate simultaneously by means of a fractional horse-power thermostatically controlled electrical motor. The settings of the doors and damper are so arranged that in the event of failure of the power supply they close automatically to a position in which the fire will be just kept alight until the motive power is restored.

The introduction of this gravity feed coke boiler revolutionizes the lay-out of boiler houses, and enables them to be maintained bright, clean, and attractive in a way which has previously been impossible with a solid fuel.



Exterior of Boiler House showing one of the Gravity Feed Coke Boilers.



Two Gravity Feed Coke Boilers each 2,000,000 B.Th.U. Capacity.

The Winchester Installation.

As an example of the capabilities of this plant, therefore, we have obtained some particulars of a rather remarkable installation, and one of which the Gas Industry may well feel proud—namely, the central heating of Winchester Cathedral, the second longest edifice of its kind in the world. And after some three months' operation the authorities have expressed themselves completely satisfied with the results.

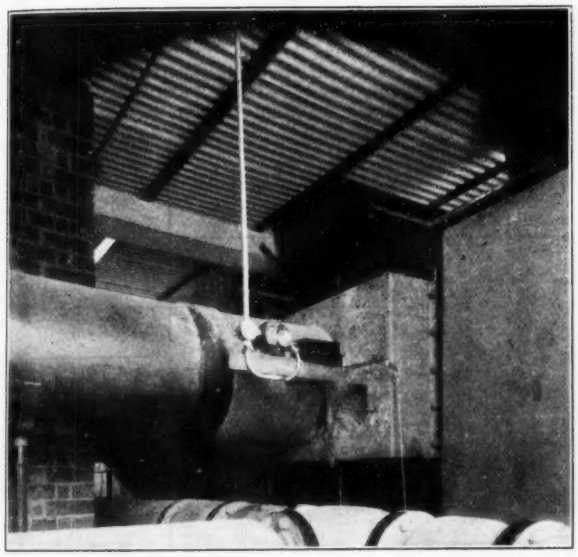
Some idea of the magnitude of the task set the heating

engineers can be realized by the main dimensions of the Cathedral, which are:

Extreme length, 556 ft.
Length of nave, 250 ft.
Extreme breadth at transept, 217 ft.
Height to roof ridge, 109 ft.

The Consulting Engineers responsible for the installation were Wingfield, Bowles, & Partners, of 28, Victoria Street, S.W. 1, and because of the importance of this central heating plant very careful consideration had to be made of every system available. The installation obviously presented many difficulties from the heating point of view by reason of the necessity for equal heat distribution in so vast a building, requiring in the boiler plant an adequate supply of heat so controlled that a maximum safety and efficiency figure could be attained.

After a detailed review of various competitive plants gravity feed coke boilers were decided upon of 2,000,000 B.Th.U. each, two units being put in of this size, complete with electrically operated damper gear. The installation is interesting in view of the fact that no solid fuel is visible either in the boiler house or adjacent to it—there being no necessity for stock yards.



Back of Gravity Feed Boilers, showing Electric Motor for Automatic Damper Control.

Actually the fuel which is held in stock is stored in brick bunkers of ten tons capacity, and the consumption of the boilers, under average working conditions, being in the region of 25 cwt. a day, there is therefore eight days' storage in the bunkers. These bunkers are situated directly over the boilers, and the coke is delivered into the individual boiler hoppers through chutes by gravity and without handling by the attendant.

The boilers themselves are of the magazine type and contain sufficient fuel in their individual hoppers to operate for eighteen hours at full load. To re-charge the magazines is a matter of only a few moments, after which the boilers will continue to function for the next eighteen-hour period. De-ashing of the grates is carried out once a day and is quite simply effected.

It is understood that the installation has an efficiency figure of over 75% and that it has worked very satisfactorily from the very first day it was put into operation. The system should show a considerable economy to the Cathedral authorities as compared with the inefficient and antiquated heating plant previously used.

Effective Lagging.

The boiler house, which is illustrated in the accompanying photographs, is a brick structure measuring some 28 ft. 6 in. by 28 ft. by 30 ft. high, with a central flue, and harmonizes splendidly with the background of buildings of similar character. A remarkable feature of the installation is that the boiler house is about 200 yards from the Cathedral, but so effective is the lagging of the underground pipes that it is understood that barely 2° is lost in transmitting the hot water this distance.

These gravity feed coke boilers represent the most up-to-date and efficient type of solid fuel heating plant and, in addition, eliminate to a very large extent the inadequacies and frailties of the human element in their control, their operation depending upon automatic instruments of an approved and reliable type. Furthermore, the whole installation is perfectly silent in operation, and the effective insulation of the boilers themselves keeps the boiler house cool.

We feel that the Heating Engineers and also the heating firm who carried out the installation are to be congratulated on a very effective plant; and other authorities who have heating problems of a similar nature under consideration would do well to inspect this plant as an example of an essentially practical, efficient, and economical installation. Moreover, it utilizes a fuel which is a stable and national commodity and with the greatest effect. If it were not for the daily removal of the very small quantity of ash one would not realize that the plant was at work, while the boilers themselves are particularly neat in appearance and occupy relatively little ground space.

We should like to acknowledge the information furnished in connection with this installation by the Winchester Water and Gas Company, the London and Counties Coke Association, who assisted with the original lay-out of the gravity feed coke boilers. We should add that the boilers were made by Messrs. Hartley & Sugden, of Halifax, and the heating arrangements were carried out by Messrs. H. Dutton & Co., of Westminster, who, with the Consultants, Wingfield, Bowles, & Partners, are to be congratulated on carrying through what must have been a difficult job so effectively.

Continental Notes

French Specification for Motor Benzole

The current specification of the Union Française des Producteurs de Benzols "Unibenzols" is given in *Journal des Usines à Gaz*, 1935, **59**, 41-50 (Jan. 20), together with a description of the French standard methods for the execution of some of the tests concerned. The specification is as follows:

(1) *Specific Gravity at* 15° *C.* Between the limits 0·865 and 0·885.

(2) *Colour.* Water white or practically so.

(3) *Moisture.* Absent.

(4) *Distillation.* Initial boiling point. Above 65° C. At least 60% at 100° C., 85% at 140° C., and 95% at 170° C.

(5) *Neutrality.* Shall show no reaction for acids and alkalies.

(6) *Sulphur.* (*a*) Free sulphur (copper strip test). Traces only.
(*b*) Sulphuretted hydrogen (lead acetate test). Absent.
(*c*) Total sulphur (Grote's method). Maximum, 0·5% by weight.

(7) *Gums.* Maximum, 10 mgm. per 100 ml.

(8) *Sulphonated Products.* Insignificant black residue when 500 ml. of the benzole is distilled from a one litre flask.

Grote's method is used for the determination of the total sulphur in preference to the lamp method since the latter gives low results when carbon disulphide is present, only 85% of the carbon disulphide sulphur being recovered. In Grote's method, the sample (4-5 gms.) contained in a 50 ml. distillation flask is evaporated in a current of primary air and aspirated into a silica tube in which combustion is effected in a current of secondary air. The mixture of benzole vapour and air is burnt by surface combustion on diaphragms of sintered glass contained in the silica tube. As absorbing liquid, neutralized hydrogen peroxide of 5% strength is employed. The sulphuric acid formed is titrated with $\frac{N}{16}$ sodium carbonate solution (1 ml. = 1 mgm. sulphur) with use of a mixed indicator (3 drops of 0·02% bromcresol green and 5 drops of 0·02% methyl red).

High-Pressure Hydrogenation of Tar and Creosote

by
H. HOLLINGS,
R. N. B. D. BRUCE, and
R. H. GRIFFITH,
of the Gas Light and Coke Company

This investigation, reprinted by permission from the Proceedings of the Royal Society of London (Series A, No. 863, January, 1935) is concerned with the addition of promoters to molybdenum catalysts,* and offers an explanation of the effects produced by the presence of a small quantity of a second substance in admixture with the catalyst.

Autoclave Experiments.—High-pressure experiments were carried out in 3-litre rotating autoclaves heated by gas. For comparative purposes the initial cold pressure was 110 atmospheres; the duration of each run was 1 hour at the reaction temperature, which was controlled within ± 2°. When cold, the pressure was reduced and the liquid products were examined, chiefly by distillation and in many cases by chemical analysis.

Raw Materials.—A low-temperature tar obtained by carbonization of Coventry coal at about 450° was used as raw material. Many other substances of a similar nature were found to give comparable results, but are not discussed here.

Catalysts.—All the catalysts described in this paper were prepared by the addition of pure colloidal silica to powdered molybdic acid. The paste of molybdic acid and silica was warmed and stirred, until the silica coagulated and a uniform mixture was obtained which could be dried completely without any tendency to separate. The amount of promoter is stated throughout as the number of atoms which appear in proportion to 100 atoms of molybdenum.

Temperature.—At 440° this particular raw material reacted sufficiently rapidly for satisfactory comparative results to be obtained.

Accuracy.—The quantity of the product which boiled below 180° was determined in each case. In order to compare the activity of the different catalysts, this quantity was expressed as a percentage either of the total product or of the raw material. It is recorded as the spirit content. With proper control at all stages the results were accurate within ± 1 unit of activity. This point was examined by several repetitions of one or two experiments.

Experimental.—The low-temperature tar was heated so that all material boiling below 200° was removed. Its composition was then as follows:

Asphalt	34·8
Tar acids	30·6
Neutral oil (below 360°)	24·7
Neutral pitch (above 360°)	19·5

The neutral oil contained 22·3% unsaturated, 54·3% aromatic, 7·0% naphthene, and 16·5% paraffin hydrocarbons, when analyzed by the method described by Griffith.†

The tar was weighed into the autoclave to within ± 0·25 gramme.

TABLE I.—*Working Data.*

Weight of raw material, 200 grammes; weight of catalyst, 10 grammes; initial hydrogen pressure, 110 atmospheres; time taken to reach reaction temperature, 1 hour; time at reaction temperature, 440°, 1 hour.

Si Atoms per 100 Mo Atoms in Catalyst.	Final Cold Pressure Atms.	C.c. Oil Formed.	C.c. Water Formed.	Spirit as % of Oil Product.	Spirit as % of Raw Material.
0	75	142	14	32	22·7
2	..	140	18	40	28
2·8	78	133	18	46	30·5
3·0	78	126	24	49	31
3·2	72	126	17	42	26·5
3·6	69	150	20	36	27
4·0	71	138	18	35·5	24·4
4·4	78	145	20	28	20·3
4·8	75	129	26	38·5	25
4·9	74	134	23	39·5	26·5
5·0	74	156	24	39	30·4
5·1	71	133	22	40	26·6
5·2	78	125	22	39·5	24·8
5·4	61	133	21	47·5	31·5
5·5	70	133	24	49	32·6
5·6	73	135	24	47·5	31·6
5·7	71	131	22	46·5	30·5
6·0	69	141	22	45	31·5
7·0	73	134	16	35	22
10·0	72	156	18	33·5	26·3

The oil distilling below 250° contained varying small amounts of phenols; where the spirit yield was good, the quantity of the distillate soluble in aqueous alkali was negligible.

* *Cf.* English Patent 349,991, Jan. 25, 1930.
† "J.Soc.Chem Ind.," Vol. 47, p. 21T (1928).

Discussion of Results.

Whether activity is expressed as the percentage of spirit in the product, or as the spirit yield from tar, the curve showing the relation of catalyst activity to promoter concentration has the same form characterized by two peaks between which the addition of promoter is actually harmful, fig. 1.

This characteristic is found to be of general occurrence with varying promoters and with varying raw materials. The relative intensity and position of the first peak and of the area of depression depend somewhat on the raw material under treatment, but the position of the second peak remains unaltered. There are, however, raw materials from which the most active catalyst produces

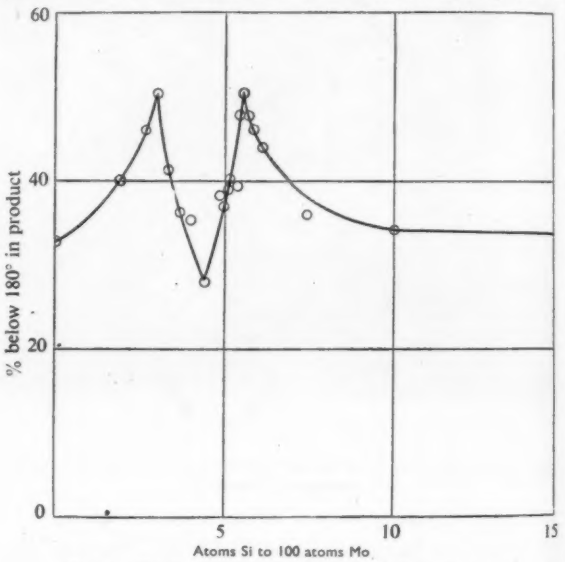


Fig. 1.—Catalyst Activity in Autoclave Experiments.

results only very slightly better than that of minimum activity. This may be due either to extreme ease of hydrogenation, as with a high-boiling paraffin, or to the absence of low-boiling hydrogenation products as in anthracene. Substances which contain much pitch or asphalt are also obviously unsuitable for comparing the activity of different catalysts.

The unusual form of the curve, and especially the area of depression, suggested that at least two factors are involved in determining the observed activity of the catalyst, and led to further investigation on the same catalysts by different methods.

Continuous Plant Experiments.

Further investigation of the same catalysts has been carried out on a small continuous hydrogenation plant, described by Ormandy and Burns.*

Raw Material.—For this series of experiments a creosote oil, obtained from high-temperature coal carbonization, was used. It contained 6% soluble in aqueous alkali. The neutral oil consisted of 26% unsaturated, 61% aromatic, 1% naphthene, and 12% paraffin hydrocarbons.

Catalysts.—The catalysts were prepared as before, except that they were made into granules together with four times their weight of powdered china clay. This procedure was adopted for economy of material, as it was found by preliminary experiment to be without effect on the results, and to give a more robust catalyst.

Experimental.—The following standard conditions were

* World Petroleum Congress, 1933, Paper 70.

chosen after a survey of the various factors; rate of hydrogen circulated 6 litres/minute; rate of oil input (approx.) 90 c.c./hour. Pressure 200 atmospheres. Temperature 460°. Volume of catalyst 200 c.c.

Each run was carried on until the activity became steady or until sufficient information for comparison was available. Hourly samples of product were withdrawn and examined, and it was always found that initial activities (expressed as the percentage spirit in product) were not maintained but fell to a steady value. Table II. includes the relevant working data.

TABLE II.

Si Atoms per 100 Mo.	Initial Activity.	Final Steady Activity.	Time Run. Hours.	Oil Rate. C.c./Hour.	Total Liquid Product as Vol. % of Raw Material.
0	28	16·5	28	94·9	100·6
0	28	16	31	92·2	99·5
0	30	18	32	92·4	100
0	30·5	17	34	92·0	100·5
3·0	22·5	15·5	31	91·3	99·7
3·5	26	19·5	25	94·4	100·4
3·5	31	20	27	91·7	102
4·0	22	14	24	91·5	99
4·5	23	14·5	30	92·4	101·5
5·25	26	17	27·5	90	100·5
5·5	30	20·5	27	91·7	102
5·5	29	22	31	91·4	102
5·5	31	21·5	31	92·0	100·8
5·5	29·5	20	29	89·5	100·7
5·5	33	21·5	42	91	101·5
5·75	30	19	27	91·3	102
6·0	26	16·5	24	90·1	100
8·0	21	13·5	25	94·4	100·5

These figures show that values for the final steady activity can be reproduced within ± 1 unit.

Discussion of Results.

The relation between promoter concentration and activity, fig. 2, is the same as that previously observed in autoclave experiments. Furthermore the position of the second peak is now shown to remain unaltered by the use of different conditions, and another raw material.

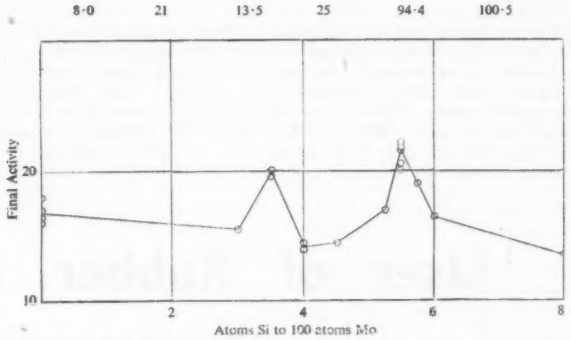
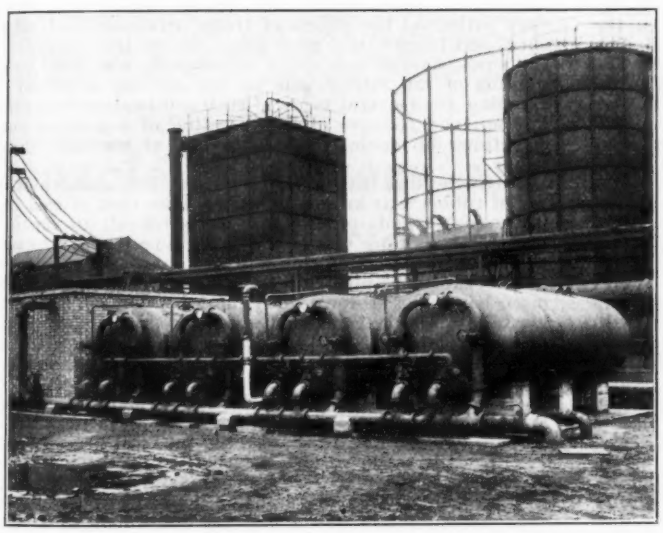


Fig. 2.—Activity Curve for Continuous Plant.



The Elliptical Filters of 60,000 gallons per hour capacity.

Filtration Plant at Wandsworth

A new filtration plant recently installed near the benzole plant at the Wandsworth Gas-Works supplies water for process purposes to an overhead tank, from which it is distributed to all parts of the works.

The water is drawn from the Thames, the pollution of which, especially as the tide rises and falls, is well known. It contains a large quantity of fine matter in suspension, and the process of filtering consists of passing the water under pressure through a bed of graded sand and thence to the filtered water tank. Here it is picked up by two centrifugal pumps and pumped to the tower. An interesting feature of the process is that the cleansing action of the filters depends almost entirely upon the film of dirt formed on the surface of the bed. When the filter is first put into commission the interstices between the sand particles are not fine enough to remove all the foreign matter, and it is the usual practice to run the filtered water to waste for a short period while the film is forming. As soon as an adequate film has appeared on the bed, the water clarifies and can then be diverted into the filtered water main.

Cleansing the Filter.

The film, as it grows thicker, sets up an increased resistance to the passage of the water through the filter, and the time comes when it must be removed. Various devices have appeared from time to time to carry out this process, such as a reverse flow of filtered water at high velocity, rotating rakes, and so forth. The method used at Wandsworth consists of agitating the bed by compressed air and running a gentle reverse flow of filtered water which removes the dirt and carries it to waste. This method keeps down the wash water to a minimum, and the absence of any moving parts is a feature of considerable value. The compressed air is supplied by a steam blower and is introduced into the bottom of the bed, where it is distributed to every point in the filter and then rises through the bed in a cloud of small bubbles. The bubbles of air throw the bed into a state of suspension and violent agitation. The particles of sand are bombarded against one another, and the dirt is freed from them, to be carried away to waste by a gentle flow of filtered water from the other filters.

Constructional Features.

The collecting system at the bottom of the filter bed consists of a transverse cast-iron collecting pipe or header, and a series of lateral sparge pipes. All these pipes are fitted with two systems of nozzles. The water nozzles, of generous proportions, are designed to keep down the frictional head in the filter and are screwed into the bottom of the pipes, while the air nozzles, which are so proportioned as to keep the air consumption down to reasonable dimensions, are fitted in the top. When filtering, both nozzles are in

operation. When washing, the air and water are separated in the sparge pipe system, the air passing up through the air nozzles as the water goes downwards through the water nozzles. By this means the two operations of blowing and washing can be carried out separately and without mutual interference. All nozzles are of non-ferrous material and therefore free from corrosion.

Battery Size.

In a big plant the requisite filtering area can be obtained either from a large battery of comparatively small units or from a smaller battery containing fewer and large filters. The latter method is the cheaper, but introduces a complication. The larger the filter the more difficult does washing become. The new battery at Wandsworth consists of four filters, each 17 ft. long, but each filter contains two independent sparge pipe systems, one behind the other, so controlled that each half of the filter can be washed separately and independently. By this means the advantages of the small unit are retained, but at the same cost as a small number of large units. The vertical cross-section of the filters is interesting. The filter beds are 8 ft. wide and some 3 ft. deep.

Water Wash Disposal.

The disposal of the wash water introduced a problem. It had to be conveyed a considerable distance with so low a hydraulic gradient that the silt discharged from the filters would probably settle out and obstruct the piping. The Pulsometer Engineering Company, Ltd., of Reading and London, who supplied the plant, arranged for all the wash water connections to be inter-connected, and the wash water is positively ejected at a sufficient pressure to drive it at a high velocity down the wash water pipe, and thereby overcome this difficulty.

Uses of Rubber in the Gas Industry

Some of the more important of the diverse uses of rubber in connection with the manufacture, distribution, and utilization of gas were discussed in a Paper by Mr. C. R. Austen (of the Gas Light and Coke Company) before the London and District Section of the Institution of the Rubber Industry on Monday, Feb. 11, at the British Empire Club, 12, St. James' Square, S.W. 1.

The paper and the discussion served to show the co-operation which has existed and still exists between the Gas Industry and the Research Association of British Rubber Manufacturers, a fact of considerable interest when it is remembered that as long ago as 1823 Charles Macintosh discovered that coal tar and naphtha, both bye-products of gas manufacture, were solvents for rubber, and he patented a process for making rubber solutions that were used for proofing fabrics. This discovery led to the production of rubber hose on a commercial scale.

Mr. B. D. Porritt (Director of the Research Association of British Rubber Manufacturers) presided at the meeting.

On the gas manufacturing side, Mr. Austen pointed to conveyor belts as being the principal direction in which rubber is used, and said it was generally agreed that rubber and canvas conveyor belts were best for handling coal, coke, and clinker. Belts 54 in. wide, dealing with 2,000 tons of coal per hour, had carried 11 million tons without showing appreciable signs of wear. Coke, by reason of its high abrasive properties, imposed a greater degree of wear, but a good belt should carry over 300,000 tons before wearing out. Where the temperature of hot coke was likely to exceed 250° F., the conveyor belt had a lining of asbestos beneath the top layer of rubber. It appeared that rubber used in belts was highly satisfactory and that excess wear could usually be traced to faulty fitting.

Other uses for rubber in the gas-works, which were mentioned briefly, included tank linings, for which it gave excellent service; hose pipes for steam, air and water; liners for chutes in coke plants; the covering of the wires of coke screens by anodic deposition; and hydraulic valves, diaphragms, joints, &c.

For the most part, the section of the paper dealing with the use of rubber in gas distribution was devoted to a consideration of rubber joints in mains, which, although finding increasing favour, have not yet established complete confidence in this country. Joints using rubber are used extensively in America and on the Continent, but to a less degree here. When the rubber joint began to be developed in this country, between 1860 and 1870, soft rubber was used, and was not protected from the oil and naphthalene then present in the gas; thus the rubber had swollen, and the result was its deterioration and partial blocking of the pipes. However, improvements in materials and methods were effected, and many joints made about that time are still in service. Recently a number had been found to be in excellent condition after 60 years' use. While some gas undertakings used rubber joints extensively, said the author, others used very few, if any.

Various forms of rubber joints for gas mains were illustrated, and Mr. Austen dwelt on their advantages and disadvantages. Of the advantages, he mentioned that they could be assembled quickly by unskilled labour, without the provision of special tools or equipment, and could frequently be made outside the trench before final laying; they withstood the effects of traffic vibration, soil subsidence, and longitudinal movements due to the expansion of the pipes; a small leak might occasionally seal itself by expansion of the rubber, due to the swelling action of the escaping gas (several types of such self-healing joints were in use); and changes in the direction of a pipeline could sometimes be made without the use of specially shaped bends.

As to the disadvantages, under the best conditions the life of rubber was known to be less than that of cast iron; leaky socket and spigot joints were difficult to repair or replace (to remove one joint of this type it was necessary to disturb the neighbouring joints to obtain sufficient clearance between the pipe ends, which usually necessitated the main being closed down until the job was completed); the mixture of oils, oxygen, and certain hydrocarbons, present in small quantities in gas, was considered by some to have a deleterious effect on rubber (these objections had been overcome to some extent by the use of yarn, lead, or canvas placed before the rubber, but it might be argued that if isolation of the rubber from the gas were obtained by the use of these sealing agents, the seal was in itself mechanically strong and leak-proof, so that the inclusion of rubber in the joint was unnecessary); and there was a wide dissimilarity in the shape and composition of rubbers used for gas joints. In a plea for uniformity of composition, Mr. Austen said that the distribution engineer was not prepared to install rubber joints merely on the strength of vague claims to high standards of quality, nor could he wait 40 or 60 years for proof of their reliability. The provision of national standards of quality and performance for rubber jointing materials would greatly enhance their reputation and increase their use.

The application of rubber in the rubber-proofed canvas bags used for stopping the flow of gas in mains, hose for connection to pneumatic hammers, and valves for high-pressure gas regulators were also mentioned briefly.

In the section of the paper dealing with gas utilization a good deal of attention was given to flexible tubing. Having pointed out that the useful life of flexible metallic tubing was determined by the effective life of the rubber packing thread used between each fold of the metal, the author said that the type of thread used most frequently was composed almost entirely of pure vulcanized rubber; but it was not entirely satisfactory. It had been found to soften at high temperatures, to shrink after prolonged use, and to absorb readily the hydrocarbon constituents of coal gas, which affected adversely its age-resisting properties. Taking advantage of recent developments in rubber technology, some gas companies specified an improved type of rubber thread conforming to rigid standards of hardness, elasticity, tensile strength, and ageing. The standardization of flexible metallic tubing was in hand; a complete specification, which would include comprehensive tests for

the quality of the rubber used in its manufacture and assembly, was in course of preparation by the British Standards Institution in collaboration with the industries concerned. Although the rubber sheath sometimes extruded over the outer surface of flexible metallic tubing might enhance the appearance and increase the strength of the tubing, it rendered the tube heavier, reduced its flexibility, and, unless made from a gas-resistant rubber, quickly absorbed the hydrocarbons which had been taken up by the inner thread, making the tube smell unpleasantly. Rubber, when saturated with gas, attained a higher concentration of the smelly constituents of gas than was present in the gas itself, and its use when in this condition was undesirable. A rubber entirely resistant to coal gas, and also satisfactory in other respects, was unobtainable yet. A flexible tube which had become impregnated with coal gas had led consumers to suspect gas leaks, and many fruitless calls to remedy such " leaks " had been made.

The " Corflex " all-rubber flexible tube, made by extrusion and having an internal solid portion attached to the inner wall which permitted the passage of gas even though the tube be kinked or stepped on, was lighter and more flexible than flexible metallic tube, was non-crushable, had greater resistance to abrasion, and withstood mechanical stresses and rough usage more readily. But it was still not quite the ideal flexible tubing: it suffered to a small extent from the odour due to the contact of rubber and gas. The assumption that rubber which had good oil-resisting properties would resist gas equally well was confirmed to some extent by the study of the behaviour of rubber in gas and in swelling agents such as toluene, benzene, and mineral oils. In this work the Research Association of British Rubber Manufacturers had given a great deal of advice. Compressing the rubber by means of a cotton or silk braiding assisted to a small extent in resisting gas absorption, but the additional cost involved by its use made its general adoption uneconomical. Special varnishes and lacquers had also been used to coat the internal and external surfaces of tubes; but the period required to effect complete evaporation of the solvent used slowed up production, and the process had been discontinued. The use of softeners should be restricted to the minimum. Rubber manufacturers had paid considerable attention to the problem of gas-resistant rubber, and many mixes with reasonably good performance had been evolved; but there remained a real and urgent need for rubber to meet this particular requirement of the Gas Industry.

Inasmuch as the safety and satisfactory performance of geysers was almost wholly dependent on the unfailing response of the rubber diaphragms incorporated in the automatic valves, the importance of a proper grade of rubber in this service was emphasized. They were often called upon to withstand prolonged contact with water, gas, and air, sometimes at elevated temperatures, and they must withstand considerable tension while retaining a high degree of flexibility. In the multipoint type of water heater the diaphragm might be subjected to higher pressures, but the use of a very strong and bulky diaphragm was avoided by arranging for the water to act upon both sides of the diaphragm, with a slight excess of pressure on one side. If the designer could use a diaphragm which was strong and flexible, yet capable of withstanding high temperatures, considerations of heat insulation of the valve would not arise, and he would be free to concentrate on producing a machine that would be compact and simple in construction. The relatively untidy appearance of many early geysers was due partly to the fact that rubber diaphragms were placed well away from the heat zone. Metal diaphragms were being used in water heaters on the Continent in small numbers.

In the course of the discussion, it was pointed out that the advantage or otherwise of standardization would depend to some extent upon whether the specification represented the best quality of the time or only an average quality, and that if the standards were not kept constantly up-to-date, they might hinder technical progress.

Reference was made by Mr. P. Richbell, of the Croydon Gas Company, to his use of rubber in joints, in connection with which he acknowledged the co-operation of the Research Association of British Rubber Manufacturers. Mr. S. F. Dunkley also complimented Mr. Austen on having hinted at the advantages to be gained by co-operation between rubber manufacturers, users, and merchants, and the need for specifications.

Benzole Recovery and Production of Motor Spirit

by
W. HODKINSON

At a Meeting of the Manchester and District Junior Gas Association at Stretford on Feb. 6, Mr. W. Hodkinson, Senior Technical Assistant and Chemist of the Stretford and District Gas Board, outlined the results obtained and experience gained in the production of motor benzole by his Undertaking during the past two years.

The policy of the Stretford and District Gas Board is to produce and sell gas to the consumer as cheaply as possible, and it follows that, by increased output, production costs can be reduced by an appreciable amount, providing sufficient plant is available to meet the increased load. It can be seen at once that the operation of a benzole plant recovering 22 galls. of benzole per ton of coal carbonized is equivalent to a consumer taking approximately 4·5% of the undertaking's output, assuming a gas yield of 70 therms per ton of coal carbonized and 1·58 therms per gallon of benzole.

The actual figures at Stretford for the year ended March 31, 1934, were 147,912 galls. of benzole made, equivalent to 241,439 therms or 6·21% of the total gas sold, when recovering 2·55 galls. of crude benzole per ton of coal carbonized.

In November, 1932, the final scheme was drawn up for a plant capable of producing motor benzole by extraction from 4 million c.ft. of straight coal gas per diem. The completed plant was placed into operation in February, 1933.

Crude Benzole Plant.

The gas is washed at the outlet of the purifiers in a Holmes horizontal rotary brush washer, steam engine driven, the drive is common to a similar type of washer used with the calcium chloride gas drying plant.

In regard to the stripping still, which is of the bubbling hood type, the preheated oil and vapours enter at a point two trays from the top. This position allows sufficient travel of the vapours to prevent mechanical carrying of the oil. Controlled live steam is admitted at the base of the still.

For the purpose of providing a high-grade distillate, the vapours from the still pass through a special column and a water cooled condenser, wherein control is exercised by means of an automatically controlled thermostat, to give an exact composition of the vapours leaving. Any hydrocarbons deposited in this condenser and column are run off from the bottom of the column into a small separator. This apparatus provides, therefore, a means for eliminating naphthalene, the oil which leaves the stripping still being substantially naphthalene free.

Wash Oil.

During the first eleven months working of the plant gas oil was used as a washing medium. Good results were obtained for the first three months, during which period the average make-up and wash oil losses amounted to 1 gall. per 26·2 galls. of benzole produced. After this period trouble was experienced with heavy sludging and the formation of oil-water emulsions in the storage tanks feeding the washing plant. At the end of six months' work heavy deposits of a pitch-like substance came down in the washer, the efficiency of the preheater began to fall rapidly, and on opening the preheater it was found that the tubes were coated with a deposit of carbonaceous matter as great as ¾ in. thick in places.

The deposit taken from the washer was a pitch-like sub-

stance, dark brown in colour, it rapidly oxidized in the air to a brittle condition.

We are now using a blended spindle oil for benzole washing, and after over twelve months we have experienced none of our previous troubles. The cost of this oil is almost twice that of gas oil; it is, however, considerably cheaper in working, as the make-up oil required to cover losses only amounts to 1 gall. per 90 galls. of benzole produced.

The comparative costs of spindle and gas oil are as follows:

—	Spindle Oil.	Gas Oil.
Initial cost per gall.	7¼d.	3¼d.
Oil wastage per 1,000 galls. crude benzole, galls.	11·11	38·17
Cost per 1,000 galls. crude benzole, pence	80·54	124·05

Equivalent to a saving of 43·15d. per 1,000 galls. of crude benzole, or £26 16s. 3d. for the 12 months ended March 31, 1934. This saving is quite apart from the cost of cleaning the scrubber-washer and benzolized oil preheater.

The analysis of fresh spindle oil as compared with spindle oil worked for twelve months was as follows:

—	New Spindle Oil.	Spindle Oil After 6 Months' Work.	Spindle Oil After 12 Months' Work.
Specific gravity at 15·5° C.	0·889	0·889	0·890
Viscosity (red) at 60° F., secs.	146	148	149
Distillation—			
Initial boiling point	339° C.	146° C.	149° C.
350° C.	2·5%	3·5%	3·5%
375° C.	40·0 ,,	42·0 ,,	38·0 ,,
400° C.	65·0 ,,	64·5 ,,	62·5 ,,

The following comparison of working results shows that the physical capabilities of spindle oil compare favourably with gas oil:

—	Gas Oil.	Spindle Oil.
Gas temperature, inlet washer	63° F.	62° F.
,, ,, , outlet washer	62° ,,	63° ,,
Oil ,, , inlet washer	65° ,,	65° ,,
Oil flow per 1,000 c.ft. gas	9 galls.	9 galls.
Viscosity wash oil at 60° F., secs.	44	146
Specific gravity wash oil at 15·5° C.	0·850	0·889
Benzole distillation—		
70° C.	..	..
80° ,,	5·0%	5·5%
90° ,,	67·0 ,,	67·5 ,,
100° ,,	80·0 ,,	85·0 ,,
110° ,,	83·5 ,,	89·0 ,,
120° ,,	87·0 ,,	91·0 ,,
Specific gravity of benzole at 15·5° C.	0·882	0·881
Solvent naphtha distillation—		
90° C.	..	..
180° ,,	6·0%	2·5%
Specific gravity of solvent naphtha at 15·5° C.	0·868	0·888
Benzole extracted per ton of coal carbonized	2·69 galls	2·41 galls.
Wash oil losses	1 gall. per 26·2 galls. benzole	1 gall per 90 galls. benzole

The spindle oil would appear to give a reduced benzole yield per ton of coal carbonized, but we are of the opinion that the higher yields obtained when using gas oil were almost entirely due to carry over of the lighter fractions from the gas oil into the benzole fraction.

Operation of the Plant.

The operation of the crude benzole plant is almost entirely automatic. The attendant's duties on this portion of the plant consist of occasional regulation of the oil pumps and steam pressures, hourly reading and logging of temperatures and pressures, and attention to general cleanliness.

The quality of the crude spirit is well maintained by the automatic control on the Taylor column.

The removal of naphthalene in the benzole washer presents no difficulties.

The efficiency of removal depends upon the temperature of the gas and wash oil at the washer, and the amount of naphthalene present in the oil leaving the stripping still.

At Stretford the average naphthalene content at the inlet to the benzole washer is 5·5 grs. per 100 c.ft., and no difficulty is experienced in removing this amount.

The naphthalene is almost completely removed from the wash oil in the stripping still and recovered in the heavy distillates.

When using gas oil as a washing medium the bulk of the heavy distillate consisted of gas oil fronts; with the change-over to spindle oil, and the consequent reduction in the amount of wash oil carried over at the stripping still, the heavy distillate consists almost entirely of naphthalene.

"Dri-Gas."

The benzole washer is situated on the outlet side of the "Dri-gas" washer, and the question of absorption of moisture from the wash oil required consideration. We have found that, providing the steam pressure is maintained above 80 lbs. per sq. in. and we continue to use superheated steam on the stripping still, no serious rise in dew point occurs across the benzole washer. The average increase amounts to only 0·5 to 0·75° F.

Gum.

The removal of the bulk of the gum forming constituents in the process of benzole washing is undoubtedly accomplished when complete stripping is aimed at. Our experience, however, would indicate the fact that partial stripping can aggravate the gum trouble.

When the erection of the oil washer was completed, it was decided that, although the stripping plant was not ready for work, we would place the washer in commission and build up a stock of benzolized oil. The benzole removed from the gas varied as the oil available reached a state of saturation, and the benzole recovered amounted to an average of 0·45 gall. per ton of coal carbonized.

Within a week of commencing operations, we experienced trouble with two of the district governors, and on examination of the valves it was found that this was due to a heavy deposit of gum. The governors were carefully cleaned and put back to work, but after only four days' work it became necessary to open out and clean one of the two governors, and in a period of three weeks this particular governor was cleaned on no fewer than four occasions.

It would appear that partial stripping, while leaving the higher boiling unsaturated gum forming constituents in the gas, removes some form of inhibitor, probably the phenols.

Sulphur.

One of the most important advantages of benzole recovery is the attendant reduction in sulphur compounds present in the gas. A large proportion of the carbon disulphide and mercaptans and practically the whole of the thiophen are removed.

The average reduction obtained at Stretford is as follows:

Inlet benzole washer	38·0 grains per 100 c ft.	
Outlet ,, ,,	20·1 ,, ,, ,,	
Reduction	17·9 ,, ,, ,,	
	or 47·1%	

It is unnecessary to emphasize the importance of this step towards a sulphur free town gas.

Working Results.

The following figures are totals and averages for the year ended March 31, 1934:

Coal carbonized	59,784 tons
Benzole content of gas inlet washer	2·92 galls. per ton coal carbonized
,, ,, ,, outlet ,,	0·38 gall. per ton coal carbonized
Extraction efficiency	87·0%
Crude benzole made	147,912 galls.
,, ,, ,, per ton of coal carbonized	2·45 ,,
Naphthalene fraction made	4,675 ,,
,, ,, ,, per ton of coal carbonized	0·08 gall.
Coal gas, therms per ton unstripped	71·18
,, ,, ,, stripped	67·18
Reduction in straight coal gas, C.V. per gall. benzole	9 B.Th.U. per c.ft.
Steam consumption per gall. of benzole	38 lbs.
Water ,, ,, ,, ,,	52 galls.

Rectification Plant.

The rectification plant was installed with a view to operating the acid washing process or alternatively a modified acid washing process producing benzole to pass what was then the proposed Gumming Test.

The plant consists of a lead lined "Typhoon" washer, fitted with belt driven agitating gear and adjustable breakers. The washer is 8 ft. in diameter by 6 ft. deep on the straight, with coned bottom. The belt drive is carried from the line shafting operating the pumps.

Acid and soda are elevated to two tanks superimposed on the washer, the elevation is carried out by means of Kestner type elevators operated by compressed air supplied by a Westinghouse type, steam driven air compressor.

The rectifying still is constructed of mild steel shell plates 7 ft. in diameter by 10 ft. long. The still is heated by a totally enclosed steam heating element, built up of 3

welded steel tubes 2 in. in internal diameter. The fitting is such as to enable the withdrawal of the complete element for inspection. Live steam can be admitted to the still for control of rectification.

The fractionating column and dephlegmator are superimposed on the top of the rectification still. The column is constructed of mild steel, 3 ft. in diameter by 12 ft. 6 in. high, packed with 2 in. diameter Lessing type rings. The rings are kept irrigated by controlled condensation from a small dephlegmator built on the top of the column itself. The dephlegmator is of mild steel and contains 110 weldless steel tubes $1\frac{3}{8}$ in. outside diameter.

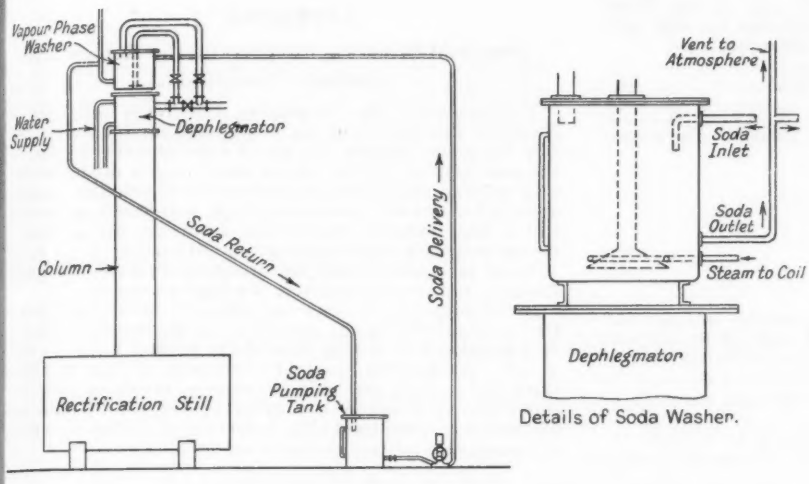


Fig. 1.—Arrangement of Vapour-Phase Washing System (Pat. 371,752, Stinnes and Pott)—Designed as a Demonstration Unit.

The vapours pass to a mild steel condenser identical in construction with that on the crude benzole plant.

Refining Crude Benzole.

Analysis of the crude benzole raised some rather difficult points as to the treatment required to produce a benzole conforming to the specification laid down by the National Benzole Company, Ltd. The crude benzole contains 1·22% total sulphur, of which 0·68% is present in the form of carbon disulphide. Therefore, to reduce the total sulphur in the refined spirit to 0·40% as specified, two points require attention:

1. Considerable reduction in the sulphur present as carbon disulphide is necessary.

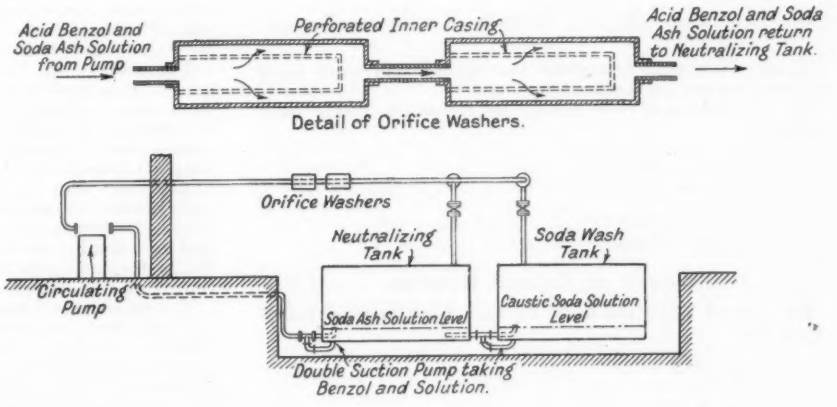

Acid Benzol and Soda Ash Solution from Pump
Perforated Inner Casing
Acid Benzol and Soda Ash Solution return to Neutralizing Tank.
Detail of Orifice Washers.
Orifice Washers
Neutralizing Tank
Soda Wash Tank
Circulating Pump
Soda Ash Solution level
Caustic Soda Solution Level
Double Suction Pump taking Benzol and Solution.

Fig. 2.—Circulating Wash Tanks (Pat. 395,645, W. C. Holmes & Co., Ltd.)—The Refining Method used at Stretford.

2. Thiophen, which comprises the bulk of the remaining sulphur, would have to be reduced to a minimum.

After a considerable amount of experimental work on the part of Messrs. W. C. Holmes and the Laboratory Staff at Stretford, the following method was evolved.

Crude benzole charge washed in the typhoon with:

1st. 2% of 10% caustic soda.
2nd. Water wash.
3rd. $2\frac{1}{2}$% of 95% sulphuric acid.
4th. Water wash.
5th. Neutralize with caustic soda.

The use of $2\frac{1}{2}$% of 95% sulphuric acid was quite successful in reducing the thiophen sulphur.

Thiophen sulphur—	
Before washing	0·54% by weight
After ,,	0·08 ,, ,,

This, however, was not the end of our troubles. On distillation of the washed charge breakdown occurred in the still at a temperature of 200° F., with the subsequent evolution of sulphur dioxide. This was obviously due to the formation of neutral sulphuric esters by the use of strong sulphuric acid in the washing system.

As the strength of acid used has considerable bearing on the efficiency of thiophen removal, reducing the acid strength was out of the question, and it was decided to reduce the contact time between strong acid and benzole by washing with 95% sulphuric acid for 30 minutes, and then run into the wash 2% of water carrying the agitation on for 2 hours as before. It was found that this practically solved our trouble. There was, however, a definite danger of recurrence of the trouble in a milder form, and, to overcome this, washing the benzole with hot caustic soda in the vapour phase was adopted.

The vapour phase washer is constructed of welded mild steel plates, it is super-imposed on the top of the dephlegmator at the head of the fractionating column, see fig. 1. The benzole vapours from the dephlegmator pass to the washer and through a caustic soda solution seal. A 10% solution of caustic soda is circulated over the washer by means of a small steam driven pump delivering from a small 50 gallon tank. The benzole vapour line is complete with by-pass, and the phase washer can be cut out of the system when necessary.

Carbon Disulphide Reduction.

The removal of sufficient carbon disulphide to leave 0·40% sulphur (by weight) in the refined spirit could only be done by very slow fractionating, and even with a very efficient column it was necessary to remove some 8 to 10%

of forerunnings. The forerunnings had very little marketable value, and therefore meant a considerable loss in revenue.

To reduce this loss of valuable low-boiling constituents contained in the forerunnings the following method was adopted. An orifice plate drilled ½ in. diameter was placed in the by-pass between the dephlegmator and the phase washer. When removing the forerunnings the inlet and outlet valves to the phase washer were closed, the by-pass valve was opened, and the vapours distilled through the orifice plate. It was found that when working with a back pressure of 4 lbs. per sq. in. on the still, the speed of distillation could be reduced to a minimum and controlled with ease. In effect we were actually sweating the highly volatile carbon di-sulphide off, and it was found that by removing only 3 to 4% forerunnings we were getting results equal to those previously obtained.

Rectified Benzole Yield.

It can be seen at once that the use of 2½% of 95% sulphuric acid entails heavy losses in the washer. The actual process losses were as follows:

Washing losses	5·7%
Forerunning ,,	3·0 ,,
Distillation ,,	5·8 ,,
Total losses	14·5 ,,
Yield of refined motor benzole	85·5 ,,

The removal of forerunnings is unavoidable unless some chemical method of removing carbon disulphide is used. Washing losses are directly due to the use of strong acid in comparatively large quantities. Distillation losses are to some extent dependent upon the amount and strength of acid used in the washing process.

The plant after installation was designed to produce refined spirit using a modified acid wash. The method being as follows:

1st. Wash with caustic soda by circulation in a pump to tank system.

2nd. Wash with acid tars collected from a previous wash (washed in the "Typhoon").
Wash with a requisite amount of strong acid (washed in the "Typhoon").
Neutralize with soda ash by circulation in a pump to tank system.

Adapting this process to our particular requirements, we designed the following method of treatment:

1st. Wash for 2 hours with a 10% solution of caustic soda—by circulation.

2nd. Wash for 2 hours with acid tars collected from a previous wash—in the "Typhoon."

3rd. Wash for 30 minutes with 1¾% of 95% sulphuric acid—add 1% water and continue the wash for 2 hours.

4th. Neutralize with 10% solution of soda ash—by circulation.

(Note.—The acid tars from the strong acid wash were collected for use in the next wash.)

On distillation of this wash the following yields were obtained:

Washing losses	4·5%
Forerunning ,,	3·0 ,,
Distillation ,,	5·0 ,,
Total losses	12·5 ,,
Yield of refined motor benzole	87·5 ,,

Analysis of Refined Benzole.

The refined spirit produced by the above method tested as follows:

Specific gravity at 15·5° C.	0·881
Distillation—	
Drip point	72° C.
100° C.	84·0%
120° ,,	89·0 ,,
145° ,,	98·0 ,,
Dry point	147° C.
Total sulphur	0·39% (by weight)
Sulphur as CS_2	0·30 ,, ,,
Colour	Pass
Acid wash test	,,

It can be seen that up to a point we have solved our trouble, but on examination of the results it will be noticed that we have very little margin of safety. For instance, the total sulphur content is 0·39%, which the National Benzole Company specify 0·40%. Again, the acid wash test is too close to the standard to be comfortable. It is, however, essential that we should wash to close margins if we wish to obtain a reasonable yield of refined spirit from the crude treated.

Control.

The control of the plant can, with careful organization, become a matter of routine laboratory work. The routine daily tests carried out include distillation of crude benzole, debenzolized oil, washed and refined spirit, acid wash tests on washed and refined spirit, and tests for naphthalene and benzole passing the washer.

The temperatures, pressures, oil flows, &c., are logged hourly in the plant record book, and this book is examined daily by the Laboratory Staff.

APPENDIX I.

Chemical Washing Process for the Removal of Carbon Disulphide.

The removal of the compulsory Acid Wash Test from the National Benzole Company's specification for motor benzole has made possible the use of various methods whereby the gum content of the refined spirit can be made satisfactory without the wholesale destruction of valuable unsaturated hydrocarbons, possessing high anti-knock properties, which was formerly inseparable from the use of concentrated sulphuric acid in large quantities.

These methods include the Inhibitor Process, the Instil Process, and several selective washing processes.

In the majority of cases one difficulty arises, and that is the question of sulphur content. Concentrated sulphuric acid washing will usually reduce the sulphur figure to within the specification limits by removal of the thiophen. With the modern methods of refining, involving only partial removal of thiophen sulphur by the use of light acid washes, it is recognized that reduction of carbon disulphide is necessary, and two methods are available:

1. Removal of forerunnings.
2. Chemical washing.

I propose to confine myself to the description of a new chemical washing process which we at Stretford intend to adopt in the course of a week or two.

Polysulphide Process for the Extraction of Carbon Disulphide.

This process is the patent of the Yorkshire Tar Distillers, Ltd., and is used by them in the treatment of a number of their benzoles.

The reagent is a polysulphide of ammonia so stabilized that the tendency of polysulphides to put back free sulphur into benzole has been overcome, it is possible to remove free sulphur from the benzole along with the carbon disulphide in the same operation, where free sulphur is present.

The reagent is agitated with the benzole at normal temperatures in the ordinary Typhoon for thirty minutes. The settlements are clean and rapid. It is possible to treat refined water white spirit and by water washing restore the colour and neutrality.

The process was investigated on a laboratory scale with a view to adoption in our own plant. The laboratory results are as follows:

1,000 c.c. of crude benzole was washed with 2% of 10% caustic soda, separated, then washed with water, again separated, and transferred to a separating funnel.

Acid tars from a previous wash were then added and agitated for 30 minutes, settled for 15 minutes, and separated. To the spirit ½% of 95% sulphuric acid was added and agitated for 30 minutes, afterwards settling for 4 hours. The separated spirit was transferred to a second separating funnel and neutralized with sodium carbonate solution.

The spirit was distilled under a standard Young column, and the first 20% removed for treatment with the polysulphide solution. The rest of the spirit was distilled to a cut point of 160° C.

The first 20%, amounting to 200 c.c., was agitated with 30% by volume of the polysulphide reagent for 30 minutes. After separating, the spirit was washed with water and finally separated.

The treated fronts were mixed with the final distillate and tested as follows:

Sulphur—	
Total sulphur	0·32%
Sulphur as carbon disulphide	0·02 ,,
Yields—	
Motor benzole	91·5 ,,
Losses in washing	3·5 ,,
Residues	5·0 ,,

It can be seen from these results that the process will give a good yield of refined spirit and also allow a safe working margin in the sulphur content.

No special plant is necessary other than the storage tanks for the reagent, and a suitable pump for handling.

I am unable to quote working costs as applied to Stretford, but the estimated costs taken from laboratory results are as follows:

% CS_2 to be Removed Expressed on the Total Make of Finished Benzole.		Cost per Gall. of Finished Benzole 2·5% S as CS_2 in Forerunnings.
0·6%	..	0·22d.
0·7 ,,	..	0·25d.

Considerable economy is shown by the concentration of the carbon disulphide into a forerunnings fraction when only this fraction need be treated for carbon disulphide.

Discussion.

Mr. H. H. THOMAS (Liverpool) proposed a vote of thanks to Mr. Hodkinson for his paper. He asked if it were more profitable to refine the benzole or to sell it as crude so that it could be refined on a large scale. Reference was made to the fact that there had been a change-over from gas oil to spindle oil, owing to difficulties experienced with the former. Trouble had been experienced at Liverpool with gas oil, but they had not found the difficulties insuperable. The main trouble had been the tendency to solidify, but very slight warming had made the oil flow again. Mr. Thomas was of the opinion that the whole of the sulphur should be removed from the gas in order that flueless gas appliances could be more strongly recommended; and, of course, working with gas oil was not a solution of this problem.

Mr. ALBINSON (Manchester), in seconding the vote, stated that the benzole plant at Partington was started on gas oil, but trouble was experienced by the oil going into a jelly in cold weather. His own impression was that the relative merits of gas oil and spindle oil were dependent upon the available washing surface. He was of the opinion that the quantity of oil used at Stretford was on the high side. The sulphur content in the benzole was a very serious one, and the standard set by the National Benzole Association was stringent and difficult to attain in works practice.

The PRESIDENT (Mr. James Carr) expressed his personal thanks to Mr. Hodkinson for the paper.

Mr. R. L. GREAVES (Stockport) stated that the stringent conditions of the National Benzole Association affected works that produced vertical gas more than those producing horizontal gas.

Mr. HODKINSON responded to the vote.

THE APPLICATION OF

by J. EDWARDS

Prepared Tars for Road Construction

In a Paper presented to the Western Junior Gas Association at Bridgwater on Feb. 9, Mr. J. Edwards, B.Sc., A.I.C., M.I.Chem.E., of Messrs. Wm. Butler & Co., Ltd., discussed the preparation and application of tar for road construction.

Road tars are prepared to definite specifications laid down by the British Road Tar Association, and those of you who are familiar with these specifications will know that there are maximum limits to which naphthalene and tar acids can be present—" the naphthalene content must not exceed 6%, and the limit for tar acids is 5% "—and it is indeed a wise procedure to keep the percentages of these products as low as possible. Excess naphthalene in tar can be a nuisance, for in roadside pots, where overheating sometimes takes place, naphthalene vaporizes on to the lids of the pots. Where possible for the manufacture of road tars the distiller uses oils as free from naphthalene and tar acids as possible. Generally speaking, the tar distiller has available for blending purposes three grades of creosote, light, medium, and heavy, these products being graded usually according to distillation range.

As a rule, the tar distiller produces " cut-back " tars, with the exception, perhaps, of a tar of very high viscosity for use as tar-concrete or hot process tar. The tar is distilled to a higher consistency than that required for any particular purpose. It is then fluxed back to the consistency required with a creosote or a combination of creosotes. How far to cut back and what type and quantity of creosote to add are matters of the utmost importance in the manufacture of road tars; and the author wishes here to emphasize that experience and knowledge are required to produce road tars which are both specific in purpose and consistently successful in application, and it is not exaggerating to say that to-day tars can be produced for any purpose—(1) tars ranging from light topping grade to road carpet grade, (2) which are successful in summer and winter, and (3) suitable for both light and heavy traffic.

Consider the question of what will happen to a tar when applied to the road. First of all a certain amount of evaporation will take place, with gradual increase of viscosity, dependent on conditions and purpose. Secondly, tar possesses the property of setting which results in an increase of viscosity and it may eventually become a solid. Thirdly, although this point is not so important as some people imagine, it is true that tar is subject to oxidation changes. It can be understood, therefore, that a tar which is suitable for one particular purpose can be quite unsuitable for another. For example, a tar suitable for the manufacture of tar-concrete destined for use on a road carrying very heavy traffic becomes incorporated in a mixture having the greatest density possible, where voids are eliminated as far as possible. In this environment the tar is not subject to such evaporation influences as would be the case with macadam laid on roads for light traffic, where the density of the aggregate would be low and the interstitial space larger in comparison.

Again, tar suitable for coating an impervious type of aggregate, such as granite or hard slag, can be unsuitable for a porous type of limestone.

These are some of the problems which confront the tar distiller. It may be of interest to learn that tar distillers are called upon to carry fifteen to twenty different grades of tar in their works. The author does not maintain that in a general way all these are necessary, but it happens that a particular surveyor of experience demands a special tar of a certain viscosity and type which he has found is very satisfactory for certain repetition work which he is called upon to undertake.

It will be appreciated that it is an extraordinarily difficult thing to correlate road behaviour with laboratory practice, and hence road construction tends to become very largely a matter of experience. As mentioned before specifications have been drawn up by a competent body to cover the uses of tars in specific conditions. These specifications are very useful, but they do not supply the whole of the information necessary to determine how any particular tar is going to act in actual use. It is true that determinations of the viscosity, of the free carbon, tar acid content, together with the distillation range, do afford a considerable amount of information, but the future specifications for tar must not be limited to laboratory tests only, but must cover also the manufacture of the tar—*e.g.*, the amount the tar is to be cut back, and the kind and quantity of blending oils to be added. These are vital factors which determine the suitability or otherwise of a tar destined for a particular purpose.

Application of Refined Tar.

Referring to the question of road maintenance and construction very little will be said about spraying tar. Usually three grades of spraying tar are manufactured to cope with different climatic conditions. The tendency during recent years has been to raise the general viscosity of spraying tars and this increase in viscosity is likely to continue. In surface-dressing a road, a surveyor has three objects in mind:

(1) A non-skid surface.
(2) Avoidance of " bleeding " during hot weather.
(3) A durable road.

These three objects are embraced in the modern practice of spraying tars of higher viscosity and then spreading hard stone chippings of at least $\frac{3}{4}$-in. size and rolling them firmly into the matrix. The importance of this rolling cannot be over-emphasized and results in the mosaic sur-

face which is both useful and picturesque. Roads dressed in this manner will keep for two to three years and will remain non-skid in all conditions except that of frost, and there is no reason why roads dressed in a proper manner should " bleed " in hot weather if sufficient chippings of the correct size are laid, rolled, and gripped.

Before the application of tar to roads by spraying all pot holes and irregularities must be remedied and dust removed from the road, and the tar should be applied to the dry road at a temperature between 200° and 240° F., dependent on viscosity. The quantity of tar to be applied to a definite road area varies considerably according to the construction of the road. In the case of a water-bound road the quantity of tar will exceed that required for a road previously tarred, but in general the area covered will range from three to six square yards per gallon of tar.

Macadam Tars.

Three-coat, two-coat, and single-coat macadam work has been practised by surveyors, but three-coat work is now rarely seen and, of the remaining two, single-coat work is definitely on the increase. Two-coat macadam has been laid both hot and cold, and the only real difference in general procedure is that in the case of the hot laid material tar of a much higher viscosity is used. The base course is prepared from aggregate ranging in grade from 2½ in. down to ¾ in., and must be thoroughly dry and heated to blood heat before the addition of the tar. The latter at a temperature ranging from 220° to 260° F., dependent on viscosity, should be added in the proportions of 7 to 10 gallons of tar per ton of aggregate. Sufficient of this base macadam should be laid upon good foundations to a finished thickness of 3 in. when consolidated by a 10-ton roller. The rolling part of the process requires attention and, from the point of view of eventual performance of the macadam, over-rolling is as bad as under-rolling. The wearing surface, as a rule, contains aggregate ranging in size from ¾ in. down to ¼ in. and, in addition, up to 10% of ⅛ in. down to dust, and in a similar manner this should be coated with from ten to twelve gallons of tar per ton of aggregate, and sufficient spread on the rolled base to consolidate to a depth of about ½ in. to 1 in.

Single-coat macadam is laid to give a consolidated thickness of 3 in., and in a similar manner to two-coat work the surface is usually sprayed with tar and chipped, followed by rolling. The aggregate usually ranges in size from 2 in. down to ¼ in., and particular attention is, as a rule, paid to the question of grading. As a rule, in the south-west of England tars of fairly high viscosity are used, the viscosity used depending not only on climatic conditions but also on the period of time which elapses between its manufacture and the actual laying of the material, and, in cases where the interval does not exceed two to three hours, viscosities ranging from 200 to 250 seconds are frequently employed. This method has given excellent non-skid surfaces requiring no attention for three years.

A more recent innovation in tarred macadam is the tar-concrete or hot process macadam hinted at in the early part of this Paper. Experimental sections of tar macadam were laid by the British Road Tar Association on the Kingston By-Pass in collaboration with the Ministry of Transport in the September of 1930, one of these being a section of tar-concrete. Up to the present day no money has been spent on these sections and they have received no surface dressing. The tar-concrete section is considered the best, and is an indication of the success which follows the application of higher viscosity tars in general. This experimental tar-concrete section has withstood heavy traffic conditions amounting to an average of 12,000 tons per day for nearly four and a half years, and is as non-skid now as on the day it was laid. Very favourable comments have been made on this section in the annual report of the Ministry of Transport. It is interesting to note also that the Kirkham By-Pass, opened officially by the Ministry of Transport on Dec. 4, 1934, contains two sections of tar macadam, one of these being a 300-yard stretch of tar-concrete. These will be subjected to regular observation over a period of several years. In the manufacture of tar-concrete great attention is paid to the question of grading, and an aggregate of very high density and of low interstitial space—*i.e.*, voids, is aimed at, this naturally calling for a very high percentage of fine material; the aggregate ranging from 1½ in. or 1 in. down to ⅛ in. and containing as much as 15% of material passing an 80-mesh sieve. The medium consists of soft pitch of round about 100° F. melting point (cube method), and both concrete and binder are separately heated to a temperature ranging from 220° F. up to 270° F., and then intimately mixed, about 11 to 15 gallons of the binder being used per ton of aggregate. The material after admixture is carried hot to the site and is spread evenly while still hot to a sufficient depth to give a consolidated thickness of 2½ in. to 3 in. after rolling. Owing to its quick setting properties, the new material permits of traffic passing over the road immediately it has been consolidated. Roads built of material something similar to that described have proved very popular on the Continent.

A few remarks on the question of failures of tar macadam may not be out of place. Considering the many ways in which tar macadam can go wrong surprisingly few failures have occurred during the last few years, and even these can generally be ascribed to deficiencies in technique or accidents. Some of the conditions which can lead to failure are as follows:

Unsuitability of the tar for the particular aggregate to be coated,
Heating of the tar to too high or too low a temperature,
The use of damp stone,
Overheating of the aggregate,
Wrong grading of the aggregate for the particular purpose required,
False economy in the quantity of tar per ton of aggregate. (A number of failures have definitely occurred through this cause.),
Too much or too little rolling,
Rolling the material when the latter is either too hot or too cold, especially in the case of high viscosity tars,
and, lastly, one of the most certain conditions of failure, insecure foundations.

Grouting.

There is one other manner in which tar is applied to road construction or maintenance and that is in grouting operations, which can be briefly described as " macadamizing *in situ*." This method of construction, also known as the penetration method, is quite common practice in this country and is very extensively used in the United States of America. Dry mineral aggregate is spread upon good foundations and consolidated to a thickness of about 3 in. The question of grading is naturally one of importance for, if the density be too great there will be difficulty in getting the aggregate wetted with tar. If on the other hand the voids are too large, the tar will run through and collect on the foundations. A useful aggregate would be one ranging from 2½ in. down to 1 in. Hot tar of a fairly high viscosity is then sprayed or run into the aggregate by machine or by hand as a binding agent for the aggregate. Hard stone chippings are then rolled into the surface. Experience in the correct grading of aggregate, and in the amount and temperature and viscosity of the tar applied, is very necessary for successful results by this method.

" Horizontal " *versus* " Vertical " Tars.

The question can pertinently be asked here " which tar is the better binder for road purposes, a ' vertical ' or ' horizontal ' tar? " The question, of course, is a controversial one. It cannot be gainsaid that there is a theory in existence, a relic of the early days, that " horizontal " tar is superior in road making qualities. One hears sometimes of macadam manufacturers and surveyors making use of the expression " good old-fashioned tar," but it is hard to say whether this has reference to a comparison between " horizontal " and " vertical " tar or, on the other hand, between tar and bitumen. It is true that " horizontal " tar possesses the better viscosity-temperature curve, and furthermore it has more rapid setting properties than " vertical " tar, but these differences can be taken care of in manufacture and application; and the point must here be strongly emphasized, which is perhaps not as widely realized as it should be, that " vertical " road tar in its preparation and application requires a technique somewhat different from that of " horizontal " tar. Many will appreciate that the utilization of both " horizontal " and " vertical " tars has resulted in magnificent roads. The experience of the author has been confined more or less to admixtures of the two crudes, and he ventures to say without fear of contradiction that roads constructed with mixed refined tars as binders do not suffer in comparison with the very best in the country.

Tar-Bitumen Mixtures.

In one manner of speaking the use of tar in roadwork began under bad auspices, in so much as that tar was originally used in so many cases actually in the crude state to lay or bind the dust on water-bound roads. The tar applied was of an extremely low viscosity and contained varying percentages of water. Consider what the surveyor had to put up with. In heating the tar in pots, the material used to froth over owing to the presence of water, ammonia gas was given off, and naphthalene deposited all round the pot. The day arrived when the surveyor required a binder for surface dressing his roads

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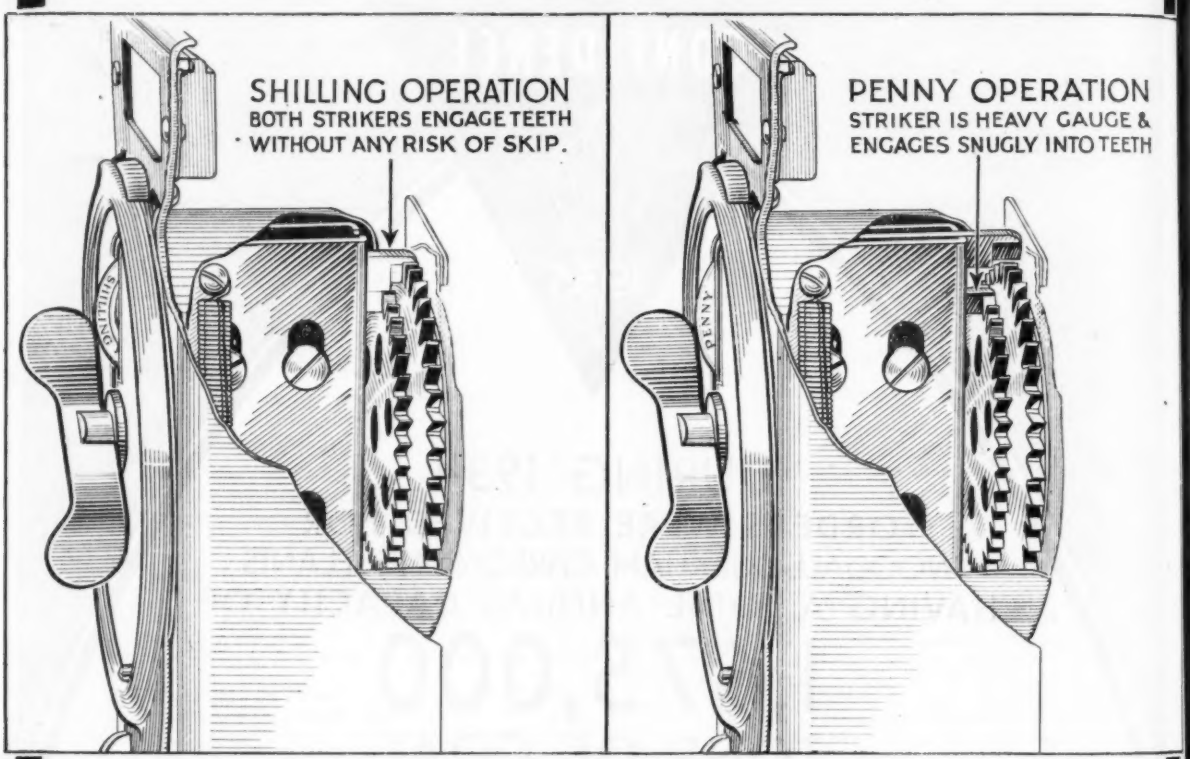

Illustration Actual Size

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and he found that the tar he had been using was unsuitable for the new purpose he had in mind, and naturally so, for the tars of extremely low viscosity then supplied naturally would not hold the chippings. The larger distillers commenced to move with the times but until comparatively recent times a large amount of tar totally unsuitable for the purpose required was being supplied.

By this time surveyors were turning over to bitumen—i.e., crude petroleum residue, as an alternative source of supply and as a material having a higher viscosity, and during recent years competition from bitumen has become keener and keener, a shortage of tar during the post-war boom further stimulating the use of bitumen. Surveyors, too, became aware that the viscosities of tar, especially of the spraying type, could be increased by the addition of varying percentages of bitumen. In consequence a keen demand for tar-bitumen mixtures arose, and there appears no room for doubt but that they have given excellent results over a long period of years.

In spite of the fact that tar distillers are producing standardized tars of any viscosity, varying in consistency from spraying grade tars to tars having a penetration value or melting point, and that the improved qualities of such tars now meet fully the requirements of surveyors, millions of gallons of tar-bitumen mixtures continue to be sold, for a number of surveyors of experience are of the opinion that such mixtures combine the merits of each constituent.

A note of warning regarding the manufacture of these mixtures would not be out of place. Unless due care is exercised in adding bitumen to tar, a serious possibility exists of destroying the valuable colloidal property which tar possesses by throwing out of suspension the free carbon content and thereby destroying the adhesive and cohesive properties of the tar. Pyrogenous petroleum residues differ enormously, not only in hardness but also in chemical properties, depending on the source and characteristics of the petroleum crude oil from which they are derived. In a similar manner, tars vary considerably and hence experience and knowledge of both constituents are necessary to avoid deterioration in the qualities of the tar. All mixtures containing more than 20% to 30% of bitumen—the figure depending on the penetration and origin of the bitumen—should be viewed with suspicion.

General Considerations.

For use as a binder in road construction tar has unique properties, for its setting rate in conjunction with its cohesive and adhesive properties, makes it suitable as a binder for any kind of aggregate or as a dressing for any kind of surface. Tar will wet any surface and, what is still more valuable, it will continue to adhere to any surface during the long process of setting and hardening. Tar definitely provides a non-skid surface and in this respect we have only to remember that roads chosen for the Isle of Man Tourist Trophy race, where exceedingly high speeds are the order of the day, are just ordinary tarred macadam roads. This is the case also with the roads used in the Ulster Tourist Trophy race. It may be asked "What does the future hold in store for tar as a binder for road surfaces?" There seems to be no reason for any pessimistic outlook. Actually the amount of tar applied to our roads has nearly doubled itself during the last ten to twelve years, and, until the far-distant problematical day when the air becomes the medium of transport, there seems to be no reason why tar should not be used in increasing quantities in the future.

One factor indeed may retard to a certain extent future sales of tar, for increased efficiency of manufacture of tar and improved technique in application will lead to roads of still greater durability whose surfaces will remain good without attention for still longer periods. Great attention is now being devoted to road matters by the Government. A considerable amount of research has been, and is being, carried out by the Department of Scientific and Industrial Research on the question of strength of materials for foundations and surfaces, and the recent appointment of the Road Research Board is a happy augury for the future.

There is no doubt that co-operation between the surveyor, the tar macadam manufacturer, and the distiller has accomplished much in the successful use of tar in road construction generally, and increased co-operation in the future will accomplish still more.

In conclusion, you will have gathered from this brief Paper that:

Firstly, the manufacture of road tar has already become a very specialized industry in which every part of the manufacture must be subject to rigorous scientific control.

Secondly, each type of road work requires its own particular grade of tar, this necessitating the carrying in stock of many different grades of tar on the part of the modern distiller.

Thirdly, improved technique of manufacture and application has resulted in the production of non-skid roads, durable in character, and capable of withstanding heavy and fast traffic conditions.

Fourthly, macadam manufacturers and surveyors are becoming more and more alive to the problem of still further improving the technique of manufacture and application, and that it is a grave error to assume that any sort of tar will do for road construction.

Fifthly, the tar distillers and the Government are alive to the importance of carrying out systematic research in the direction of increasing our knowledge not only of tar itself but also of its most efficient application to modern road construction.

No reference has been made in this Paper to the economics of road construction and maintenance, but it is, of course, widely known that refined tar is the most economical binder which can be used for that purpose. Not only is it the most efficient and best all-round material which can be used, but furthermore it has the advantage of being a 100% British product, the increased use of which will react favourably on those primary industries of paramount importance, namely, the coal and steel industries, on which the prosperity of this country has been founded.

Discussion.

The PRESIDENT (Mr. D. L. Copp, Exeter) remarked that the preparation of tar for road work concerned all members in that tar disposal was essentially part of gas manufacture. He asked Mr. Edwards whether there was an economic limit over which tar concrete could be transported, as presumably it must be transported hot and laid before it became cold. He would also like to have opinion about carpets of bitumastic materials laid on concrete foundations.

Mr. J. H. CORNISH, Sen. (Managing Director, Bridgwater Gas Light Company), asked whether it was a fact that the stocks of tar in the country had increased and the demand was not so good.

Mr. B. G. HAWKINS (Plymouth) asked whether it was possible to prepare tar-water emulsion from any tar similar to emulsion in common use prepared from bitumen.

Mr. K. L. CLARK (Weston-super-Mare) inquired the reason for brittle tar macadam being sometimes turned out from a tar which was generally satisfactory, also whether rapid hardening emulsion could be prepared from coal tar.

Mr. S. HOLE (Bath) commented on a point mentioned in the paper that bitumen mixtures of more than 20% bitumen should not be prepared, while they were frequently asked to prepare such mixtures by surveyors. He also mentioned the diversity of opinion still existing among road engineers as to what was the best tar. Preparations which suited one surveyor had not met with the approval of another.

Mr. EDWARDS, replying, said that in the case of tar concrete laid on the Kingston By-Pass he believed the hard stone and the tar used were available quite near the site. This certainly was a factor in the use, as the material must be kept warm. Steam wagons, and in some cases motor vehicles, were now being used in which the waste products from the power unit passed through a coil to keep the tar load warm in transit. A similar and more non-skid surface could be made from tar. Replying to points about emulsions, it was stated that experience had shown that a small percentage of bitumen added to tar water emulsions assisted the stability of the product. It was possible to produce emulsions with almost any "reversion" speed—say, one which would be quite dry three minutes after application to the road, or one which would not have reverted in an hour. The difficulty with emulsions was vibration during transit as this tended to destroy the emulsion.

The cause of brittle tar macadam was generally overheated stone, which caused the more volatile constituents of the tar to volatize and destroyed the cohesive properties.

Dealing with tar-bitumen mixtures, Mr. Edwards stated that if the bitumen was a pyrogenic residue, best results were obtained with proportions up to 15%. It must be borne in mind that bitumens varied, and he said the harder the bitumen the more could be added to tar with safety. Regarding natural asphalts, these came under a different heading, and it was true that a greater percentage of this type could be successfully incorporated in a tar-bitumen mixture. Of course, if an order was received for mixtures with a high percentage of bitumen they must be prepared. Mr. Edwards concluded by expressing an optimistc outlook for tar products in road construction. The increase in tar stocks in North of England was due to improvement in coke oven business.

Mr. J. H. DYDE (Plymouth) proposed a hearty vote of thanks to Mr. Edwards, which was supported by Mr. S. B. JONES (Clevedon), and received with acclamation.

A film showing very comprehensively the preparation of road tars and treatment of distillates at Messrs. Butler's Works was shown by Mr. Peter Butler.

At the conclusion of the meeting tea was served at the Bristol Hotel, Bridgwater, and the thanks of the Association were expressed by Mr. HOLE, to which Mr. J. H. CORNISH, Snr., replied.

Applications of Industrial Gas

by T. R. SAWERS

In a Paper read by Mr. T. R. Sawers, of Falkirk, before the Scottish Junior Gas Association (Western District) on Feb. 9, the Author described some of the loads which go to make up his Undertaking's 19·5% industrial gas consumption.

Opinions differ widely as to what charges should be omitted from the Revenue Account, or modified in calculating the price to be charged for industrial gas; hence the reason for such a multiplicity of scales of rates and tariffs. There are, however, certain charges which obviously should be eliminated, such as attending to general consumers' complaints, repairs and maintenance of cooking and heating appliances. Other items, of which only a very small proportion is applicable, are repairs and maintenance of service pipes, meter repairs, meter surveying, and collecting and administration charges. It will also be readily conceded that the bulk of the distribution standing charges and the rates and taxes incidental to these should be excluded.

An example will illustrate clearly many of the above contentions. An industrial consumer in Falkirk consumes 29 million c.ft. annually. The distribution capital in this instance amounted to £188. To obtain an output of 29 million c.ft. by means of domestic consumers using an average of 30,000 c.ft. per annum would mean 966 services, meters, and stoves, and would involve a capital expenditure of over £9,500. It will also be noted that it would mean 966 times the number of services, meters, and stoves to be maintained; 966 more visits each survey for meter reading and 966 times the amount of clerical and book-keeping work to be executed.

Other factors which have a bearing on the matter may be mentioned. We should give concessions to the "full week all the year round" load, because it is a type of load that reduces operating costs and capital charges. Any load off the peak demand should not have to meet storage and distribution charges. It also assists in reducing the fluctuation of the number of retorts in operation. A manufacturer with a high summer load and small winter load may be given special rates because no extra plant or increase in the distribution system is required for this type of load. There is also the heavy intermittent load that may occur at the time of peak demand. We have to be prepared to meet this without notice, but the annual consumption must also be considered.

It is generally agreed, however, that the lowest price should not be less than the net cost of gas into the holder, *plus* distribution charges as applicable to that particular consumer, interest and sinking fund charges, and the rates and taxes thereon.

In Falkirk the industrial gas load is 19·5% of the total gas sold, and the following are some of the loads that have assisted in increasing the total.

Baking.

This is a load that is common to every town, and, provided that the right price is given, this should be won over to gas firing. There are various types of ovens that may be classed under internally fired and externally fired, static and conveyor types. Each type of oven has its advantages and disadvantages, and the oven is selected according to the amount and class of work to be done. In the case of the small baker whose work is often intermittent the internally fired is used where quick heating is desirable. For the larger baker the large externally heated oven is installed because it is more efficient over long preiods of use and turns out goods of a high standard. The conveyor type is used in the large bakehouse where mass production is called for. We sometimes find the three types mentioned in use in a large bakehouse dealing with all classes of baked goods.

The travelling chain type of baking oven on which the following test was carried out is by Messrs. Baker Perkins, Ltd., and the gas compressor and burner equipment by Messrs. Keith & Blackman Company, Ltd.

The oven is one for "small" confectionery with a baking chamber 45 ft. long by 5 ft. 4¼ in. broad by 12 in. high, there being 8 in. between the top of the tray and the top of the oven chamber and the height of the oven is 4 ft. 10 in. The body of the oven is constructed with steel inner and outer plates packed with non-conducting material. Steam points are fitted at the feed and delivery ends as well as an intermediate one for carrying off the steam and products of combustion, there being special galvanized hoods fitted to the feed and delivery ends.

The travelling chains are of the high camel back hexagon bush type with rollers running on skeleton tracks, which on their return are carried on sprockets on shafts underneath the oven chamber. The chains carry trays side by side 30 in. by 18 in. or 29½ in. by 16½ in. The oven is heated by means of Baker Keith high-pressure gas burners complete with the necessary injectors, cover plates, self-closing observation doors, headers, gauge boards, and lighting torches. There are 29 burners placed above the goods to be baked and 40 below the top portions of the travelling chains. The injectors which are fixed horizontally are fitted with single corrugated strips and the injector in conjunction with an inner tube in the burner proper allows for adjustment of the heat along the length of the burner. The design of the burner ensures complete combustion under all conditions. Once the air is regulated to suit the gas no further adjustment is necessary as the correct amount of air is carried in with the gas under all possible conditions. The oven is driven by means of a patent Baker Thomson driving gear and variable speed gear combined, standing at the side of the delivery end of the oven.

The rotary gas compressor, Fig. 1, is supplied by Messrs. Keith & Blackman Company, Ltd., designed for a capacity of 2,000 c.ft. per hour. It is fitted with an automatic pressure regulating and return valve, which can be loaded to give the desired pressure.

The test was carried out not as an efficiency test on the oven but as an illustration of the flexibility of the oven and the variety of goods that can be baked continuously. The following is a list of the goods baked in the test:

4 types of biscuits.
3 types of scones.
3 types of rolls.
6 types of cookies.
8 types of buns, also cream loaves, soda farells, snowballs, Dolly Vardens, and French teabread.

That is, 29 different types of goods baked, giving a total of 39,507 articles.

Results of Test.

Duration of test	5 hrs. 52 min.
Number of articles baked	39,507
Weight of dough including ingredients	3,578 lbs.
Weight of articles after baking	2,712 lbs.
Weight of moisture given off	866 lbs.
Gas used to heat oven from 77° F. to baking temp. 625° F.	2,005 c.ft.
Time taken to reach baking temperature	1 hr.
Gas used in test	10,425 c.ft.
Maximum number of trays in oven	62
Number of trays used in test	1,121
Weight of ,, ,, ,,	14,573 lbs.
Average temperature of flue gases	407° F.
Speed of conveyor	10–12 min.
Electric current used in test	6·25 KW.
Average pressure of steam to prover	5 lbs./sq. in.
,, temperature of steam to prover	226° F.
,, ,, in prover	140° F.
Time in prover	35–50 min

The oven reached baking temperature in one hour, but it was allowed to heat for a further hour until it was well "saturated," and at a higher temperature, to allow for a drop in temperature when the trays of cold articles were first added. The first articles to be added were scones at 4.34 a.m., being preceded by 14 "pilot" trays to prevent burning. These were immediately followed by morning rolls at 4.53 a.m. which were passed through continuously until 6.20 a.m., taking 10 minutes to pass through the oven. The rolls were followed by the variety of smalls already enumerated. From the starting up until the finish of the rolls the oven required no attention. The variety of

smalls required different firing, and an operator was kept to put out and light up burners as required. One or two little gaps of a few minutes were thus made between the last articles in the oven and those ready to follow, due to the temperature of the oven being adjusted for each class.

Enamelling.

Messrs. R. & A. Main, Ltd., have within the last year or so re-organized and extended their enamelling shops, and it is interesting to note that they have installed a Gibbons' Dressler tube gas-fired muffle, constructed by Messrs. Gibbons Bros., of Dudley, three Berlin black ovens by Messrs. F. J. Ballard & Co., Ltd., Tipton, replacing coke-fired ovens and a converted oil to gas-fired conveyor drying oven. They have also three open type drying ovens for special work and in consequence they have increased their annual consumption by 27 million c.ft., and the following is a description of the various plants and processes for which gas is used by them.

The enamel is made from different mixtures of materials such as quartz, felspar, fluorspar, borax, soda ash, cryolite, and potassium nitrate depending on the type and quality of enamel required. Weighed quantities are put into a

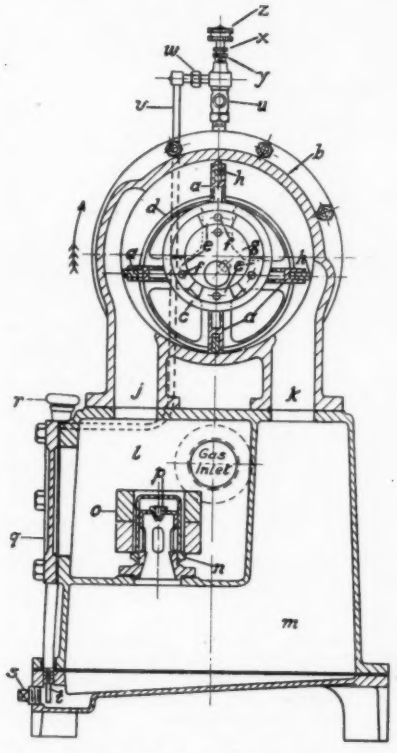


Fig. 1.—Section of Keith & Blackman Compressor.

mixer and then into a rotary smelter where they are smelted at approximately 1,100°-1,200° C. and dropped into cold water, breaking up into " Frit " which in turn is put into a grinder where water and various colouring oxides are added in correct proportions. Clay is also added for the purpose of holding the enamel in suspension. After grinding, the thick liquid that is formed is then strained and laid aside for use in the sprayers.

Conveyor Drying Oven.

The sheets and castings after they have been sprayed with enamel in the usual way with compressed air at 50 lbs. per sq. in. are then passed through the gas-fired conveyor oven at a temperature of 295° F. The ordinary " in and out type " is being replaced by the conveyor type, and many of the latter type of oven using other fuels have been converted to gas firing owing to their maintenance costs. Factors to be considered in drying operations are (1) the amount of moisture to be extracted; (2) the rate of air movement to remove the moisture; (3) the proper drying temperature; and (4) the time required for complete drying. Too high a temperature will cause skin drying, and blisters will appear and burst due to the expansion of the moisture under this skin. The time required for drying depends upon the maximum temperature and the rate at which the air is circulated.

The conveyor drying oven by Messrs. F. J. Ballard & Co. was converted from oil to gas, the only alteration to the air-heater being the replacement of the end plate and the fixing of the gas burner with automatic control. The burner is of the bunsen type and the gas at district pressure is conveyed to the burner by a 1½-in. pipe. Before the alteration the attendant after lighting up had to stand by for approximately 25 minutes to prevent the burner going out and filling the air with smoke. Now he can leave the oven immediately he lights the gas burner. When oil was used, the oven had to be scraped and brushed clean repeatedly and a number of " wasters " were produced due to drops of oil falling on the enamel-ware.

With gas heating the oven walls in the heating zone can be easily cleaned of fine dust by a vacuum cleaner. The oven is of the camel backed type made of light steel sheets with 2-in. insulation, and the conveyor chain travels inside and outside of the top of the oven. It is driven by an electric motor and variable gear placed beneath the exit end. The oven is fitted with a separate direct-fired type of bricklined air heater fixed underneath the oven. The air is drawn in through a filter into the gas flame by means of the fan exhauster blower fitted between the air heater and the oven, and the air is heated to the required temperature. Dust is thus eliminated, preventing spoiled work and a certain amount of the heated air is re-circulated after passing through the heater again, thus saving a quantity of fuel. The work to be dried is suspended from the conveyor and is passed through the oven. A constant temperature of 295° F. is maintained automatically by a Foxboro remote control pyrometer which controls the air pressure to the diaphragm of the gas control valve and also gives a record of the temperature during the day's working.

In a test carried out with grey mottled and white enamelled linings the following results were obtained:

Time taken to raise temp. of oven 50° F. to 295° F.	19 min.
Working temperature	295° F.
Gas used to reach working temperature	260 c.ft.
Gas used per hour under full load	990 c.ft.
Time taken to pass through oven	25 mins.
Air circulated	1,400 c.ft./min.
Average temperature of inlet air	58° F.
Air pressure to control valve	14 lbs./sq. in.
Time oven is in operation per day	9¼ hrs.
Average weight of full load on conveyor	17 cwt. 6 lbs.
Average throughput per hour	1 ton 52 lbs.

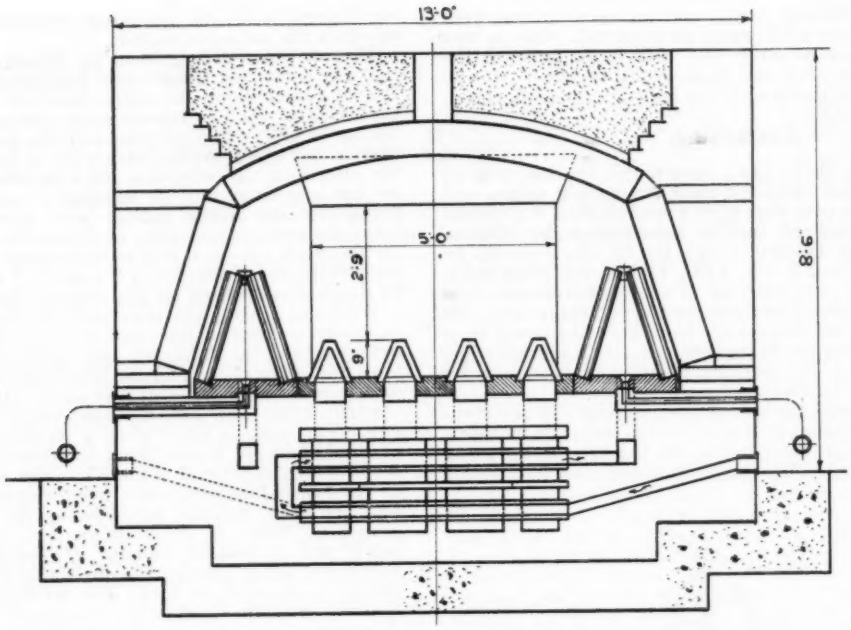
Before conversion the average oil consumption per hour under full load was 2¾ gallons.

Gas-Fired Muffle.

After passing through the conveyor drying oven the enamelled sheets are placed on " Perrit " bars and deposited on the hearth of the Dressler tube gas-fired muffle installed by Messrs. Gibbons Bros., Ltd., of Dudley. There they are heated from 5 minutes to 7 minutes depending on the class of enamel.

The dimensions of this muffle, Fig. 2, are 15 ft. long, 5 ft. wide, and 3 ft. high. There are 7 burners of the bunsen type on each side of the muffle. They are fixed at the foot of the Dressler tubes with air orifices concentrically placed to each burner. The burners are lighted in the usual way at first, but the primary air is cut off after heating up and thereafter preheated air is used. The air passes through the recuperator situated underneath the oven and is preheated so that the density of the air entering the Dressler tubes will be near the density of the gas used. The mixing of the air and gas takes place by slow diffusion and in passing along the tubes the partial combustion obtained results in a flame of high luminosity. The rate of diffusion results in the gas being completely consumed by the time it reaches the end of the tube. This is known as the " diffusion flame system," and produces a long high heat radiating flame. The heating gases then pass through the inverted " V " shaped hearth towards the back of the muffle and return underneath them to the front and then through the recuperator to the chimney. It is necessary to provide active hearth heat when increased output combined with uniform heating is desired, thus the " V " shaped hearth is so constructed to increase the radiating surface in the heating chamber.

The gas supply to this muffle, Fig. 3, is via a 4-in. service, and a Peebles governor is fixed and set at 3 in. W.G. for the burners. There is a gas pressure recorder and also an indicating pyrometer giving the door end and the back of the muffle temperatures to the operator. Recording pyrometers are also fixed in the shop superintendent's office. The muffle is also fitted with Brown temperature controls. The heating up of the muffle takes several weeks, due to the large body of brickwork to be heated. This muffle is



SECTION THRO' DRESSLER MUFFLE.

FIG. 2.

now under repair and two " Eddy Ray " burners are being fitted, one to each Dressler tube at the back of the furnace.

A furnace with an inactive hearth will probably be suitable for light steelwork which can be heated from top heat only, but the heavier work such as cast iron, where the heat demand is considerable, the active hearth is required. The principle of heating a vitreous enamelling chamber is by the provision of heat radiators such as the hearth and sides in the gas muffle and the crown also in the case of the oil muffle. Sometimes the back wall is utilized. The high combustion chamber temperature is due to the combustion products circulating through a single combustion chamber as a heavy strata of gas the core of which does not lose its sensible heat with sufficient rapidity.

The combustion of gaseous products in the Dressler tube system inside the chamber means that heat losses due to the high temperature of the walls, external flues, &c., are eliminated.

The following results were obtained under working conditions in the Gibbons Dressler tube gas-fired muffle:

Ground Coated Sheets.

Combustion chamber temperature	1,200° C.
Working temperature for sheets	850° C.
Average gas consumption per hour	3,000 c.ft.
Approximate number of hours per week	150 hrs.
Average output per hour of enamelled sheets.	953 lbs.
Approximate output per week of 150 hrs.	68 tons 6 cwt.
Gas consumption per lb. treated	3·14 c.ft.
Average weight of load	100 lbs.
Time of charge in muffle (depends on class of enamel)	5 min.
Temperature when coloured enamel sheets put in	780° C.

Enamelled Cast Iron.

Combustion chamber temperature	1,050° C.
Working temperature for cast iron	750° C.
Average gas consumption per hour	2,500 c.ft.
Average output per hour of enamelled cast iron	980 lbs.
Approximate output per week of 150 hrs.	65 tons
Gas consumption per lb. treated	2·55 c.ft
Average weight of load	480 lbs.
Time of charge in muffle (depends on class of enamel)	25–30 min.
Temperature where colour enamel cast iron put in	730° C.

Oil-Fired Muffle.

The following are results of a test taken at the same works from an oil-fired muffle by Messrs. F. J. Ballard & Co. for comparison. The muffle is similar in size to the gas muffle and is fitted with Brown's temperature control and recorder:

Enamelled Cast Iron.

Combustion chamber temperature	1.250° C.
Working temperature	750° C.
Average oil consumption per hour	9·0 galls.
Average output per hour of enamelled cast iron	1,000 lbs.
Approximate output per week of 150 hrs.	66 tons
Oil consumption per lb. treated	0·084 lb.
Average weight of one load	480 lbs.
Time of charge in muffle (depends on class of enamel)	25–30 min.

Berlin Black Ovens.

Gas fires, mainstats, high-class cooker burners, &c., are heated in Berlin black ovens. These are chambers 6 ft. high by 4 ft. 9 in. broad by 6 ft. 9 in. deep, built with sheet steel, and have doors at either end so that the racks with the goods hanging from them can be run in from the sprayers' end, taken out at the finishing and inspecting end. Each oven is heated by three burners running from back to front underneath a false floor plate over which passes air which is heated and passed through perforations in the floor plates into the chamber. The products of combustion rise up either side of the oven in the spacing between the inner lining and the outer casing, and there is a damper on the flue so that the rate of travel of the products can be regulated to some extent.

There is also an air damper on the top of the oven to regulate the heated air and fumes leaving the oven. If this damper is not sufficiently open to allow the fumes to escape then the black enamel would come out cloudy. The ovens are controlled by Cambridge temperature controls and indicators. The oven used for coloured fires is similar but the temperature is lower, being 285° F.

This conversion from coke-fired ovens to gas-fired ovens has resulted in a greater output and better finished articles. A great deal of time was lost due to temperature fluctuations before and after coke firing, and the dust from the fuel caused damage to the smooth finish of the enamel. On conversion the articles can now be heated at a regularly maintained temperature, and a definite time can be given to each type of load put in. The fluctuation in temperature when coke-fired meant that the load had sometimes to be put back into the oven again to finish off.

Results of Test.

Consumption of gas in oven	549 c ft./hr.
Time taken to heat up from 60° F. to 440° F.	45 min.
Gas used to heat up	480 c.ft.
Working temperature for black	420° F.
Temperature control set at	440° F.
Reduction in temperature due to load	20° F.
Time/load in oven	1 hr.
Average weight of load put in	635 lbs.
Time ovens are on per day	9½ hrs.
Working temperature for colours	275° F.
Temperature control set at	285° F.
Reduction in temperature due to load	10° F.
Time taken to heat up from 60° F. to 285° F.	45 min.

Metallization.

An interesting plant using coal gas is one for spraying metals on steel, cast iron, wrought iron, &c., as a protective coat, or on castings to fill " blow holes." Aluminizing is a patented process for the protection of metals from scaling, due to exposure to high temperatures. It consists of spraying an aluminium coating on to the article to be treated and by means of a suitable heat treatment alloying the aluminium with the base metal. Aluminizing can be used with advantage at all tempera-

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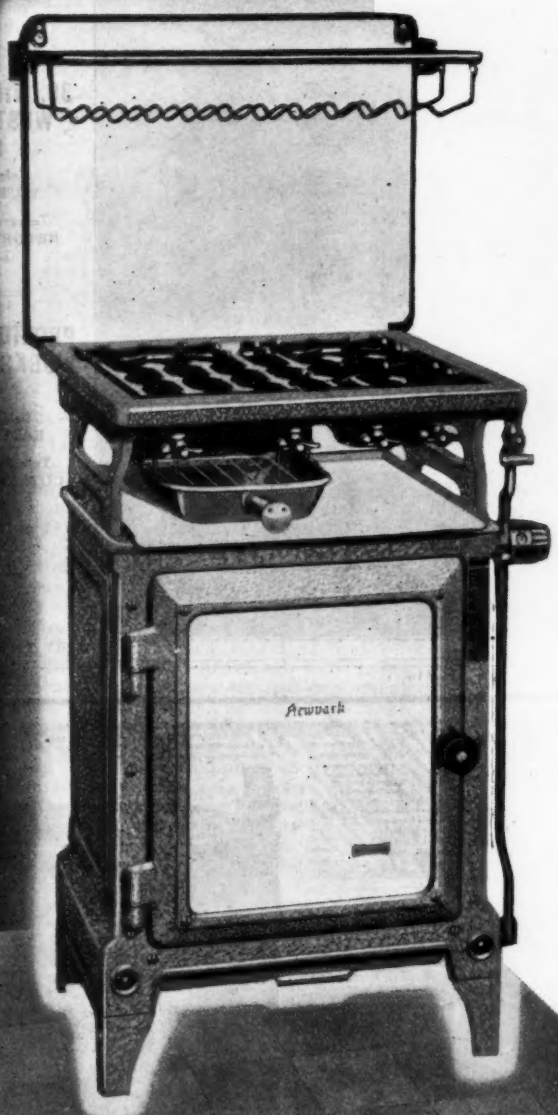

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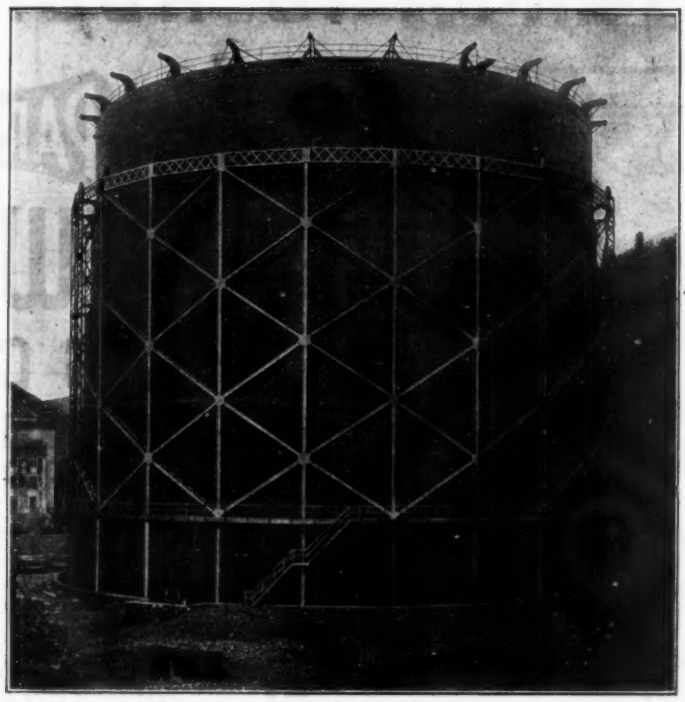

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tures up to 1,000° C. Being unaffected by hot oxidizing gases, it also completely excludes them from contact with the iron and thus scaling is prevented. Even if abrasion occurs, which is sufficient to remove the outer skin, of alumina, a fresh layer is immediately formed by the oxidation of the exposed aluminium alloy underlayer. Articles of almost any size can be protected against heat oxidation by aluminizing.

Metallization provides protection in one way or another from most corrosion-producing atmospheres; zinc spraying for atmospheric corrosion, aluminium for sulphurous corrosion, nickel, lead, &c., for corrosion from other chemically impregnated atmospheres.

The following table gives approximate consumptions and pressures of coal gas and oxygen, and also the weight of metal sprayed:

—	—	—	—	—	—	Coal Gas.		Oxygen.	
Metal.	Dia. MM.	Speed. Ft./Min.	Metal Sprayed. Lbs./Hr.	Weight of $\frac{1}{1000}$ In. Metal per Sq Ft. Ozs.	Area in Sq. Ft. Covered per Hr. $\frac{1}{1000}$ In. Thick.	Press. Lbs./Sq. In.	C.Ft. per Hour.	Press. Lbs./Sq. In.	C.Ft. per Hr.
Tin	1·5	19	9·8	0·601	39	24	61	23	37
Zinc	1·5	12·5	6·4	0·663	23	27·5	69	25	41
Aluminium . .	1·0	14·0	1·15	0·211	13	27·5	69	26	43
Copper . . .	1·0	8·0	2·3	0·732	8	27·5	69	26	43
Brass	1·0	8·5	2·4	0·710	8·5	27·5	69	26	43
Nickel . . .	1·0	5·0	1·4	0·730	4·75	27·5	69	27	44
Iron	1·0	5·5	1·3	0·640	4·75	—	69	27	44

Large-Scale Water Heating.

At Falkirk the Public Baths Committee had decided upon a system for their plunge bath, slipper baths, &c., and since this system required steam for heating three vertical boilers were installed. The four fuels were considered, and the Gas Department was successful in obtaining this load, being able to give special rates for this consumption. The vertical boilers were made by Messrs. Cochrane & Co., Annan, and were designed for solid fuel. The smoke boxes were altered and by means of baffle plates the length of travel of the products of combustion was increased, the tubes themselves being travelled in three directions by the products. Special fire doors were fitted with three special burners, and burner control equipment by Messrs. Autocontrol Boilers, Ltd.

The gas is supplied through a 6-in. cast-iron pipe to a 6-in. Peebles Mercurial Governor with a 4-in. cast-iron pipe at the outlet supplying 1½-in. malleable pipes to the burner control devices. The by-passes are taken from the 4-in. cast-iron pipe to the pilot lights and the pressure of gas is governed to 2-in. water gauge in the 4-in. cast-iron supply pipe.

The boilers are worked by induced draught, small exhauster blower fans being fixed to the flues from the smoke boxes. To start up a boiler the gas supply to the pilot lights and burners is kept shut so that on starting the fan, the boiler is given a short run to clear away any gas that may have accumulated in the grate area. Then the pilot lights are lighted and the gas turned on to the control. The fan is started and the suction so caused is transmitted through a ½-in. pipe to the burner control diaphragm so that the tappet arrangement fixed to the diaphragm lifts poppet valves one at a time, allowing one burner at a time to light.

The nozzles of the burners are filled with corrugated strips giving a turbulent and intimate mixing of air and gas. The flames impinge on refractory material placed checker wise on the grate so that the gas is properly consumed before coming into contact with the boiler surface.

An automatic switching device is fitted to the pressure gauge which switches off the fan controlling the boiler at 50 lb./sq. in. and restarts at 48 lb./sq. in. There is also an automatic switch for high and low water levels.

The condensates are returned from the calorifiers to a common collecting cylinder and this is used as boiler feed water delivered to the boiler by a small feed water pump. This has to be made up now and again with cold water due to leakages or direct use of steam. The following results were obtained in a test:

Duration of test	4 hrs.
Gas used in test	9,162 c.ft.
Gas used per hour at N.T.P.	2,258 c.ft.
Water used in test	280 galls.
Feed water per hour	700 lbs.
Temperature of feed water	160° F.
Average steam pressure	41 lbs./sq.in.
Flue gas temperature	383° F.
Chimney pull by fan	4 in. water gauge
Analysis of flue gas	CO_2, 10·8%; O_2, 4·1%; CO, 0·4%
Thermal efficiency	83·0%

The above system of heating bath water is not a very efficient method and where no steam is required the most efficient method of heating is by the hot water circulating

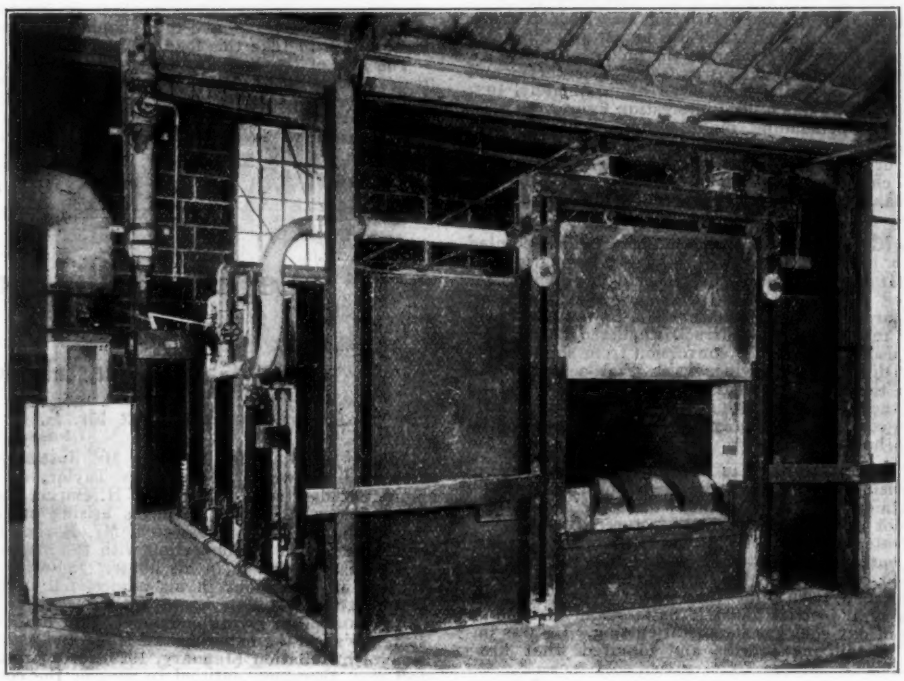

FIG. 3.—GIBBONS DRESSLER TUBE GAS FIRED MUFFLE.

system. The Falkirk Baths Committee are likely to change over to this system in the near future, as Auto-control Boilers, Ltd., have guaranteed a saving of, at least, 25% in the gas consumption. The circulating system is in use at the Clapham Municipal Baths, using "Vesta" boilers, and an efficiency of from 92% to 95% is obtained with these boilers. It has been brought to my notice that in the near future a gas-fired hot water circulating system will be installed in Scotland for bath water heating.

Discussion.

The PRESIDENT (Mr. John Greig) said that it was but natural that a Falkirk man should be interested in the industrial uses of gas, since Falkirk was the centre of the light castings industry in Scotland. The author had said that there were four classes of fuel, and that the use of solid fuel would diminish and be replaced by gas or electricity. It should be noted, however, that while greater efficiency in the use of gas and electricity was now being obtained the same was also true of coal burning, and there had been cases where oil had been replaced by coal. The industrial gas salesman required to have a special knowledge, different from that of the ordinary gas salesman, and in different districts he had to study different conditions. He wondered if Mr. Sawers had had any experience of gas replacing coke in the firing of crucible furnaces where intermittent heating was required. In a change-over from one fuel to another there were so many factors involved that it was very difficult to assess the difference in terms of £ s. d., and it was in this direction that the specialized knowledge of the salesman was of great value. He wondered if Mr. Sawers had had any trouble with the checkered brickwork in his bath water heating installation. He thought that there was a great future for metallization, but suggested that it was rather expensive for use in protecting gasholders. He also wondered if it would save the expense of painting.

Mr. C. A. POULSON (West's Gas Improvement Company, Ltd.) said that Falkirk had foreseen the industrial gas load. The price of gas in Falkirk to slot meter consumers was the fourth lowest in Scotland, but the price for industrial purposes appeared to be the lowest. The domestic was a very useful load, and though it showed fluctuations these offered no difficulty. There were very few works which could not cope with an extra load of 10% without alteration in existing plant, and the increased load should mean a lower price. The problem was how to get the load. Mr. Poulson suggested that a census of all possible industrial consumers should be made and a special study of their particular requirements made. This had been done extensively by some of the larger undertakings. If the use of gas could show a reduced cost for an article or a manufacturing process a record of this reduction should be shown and few manufacturers could afford to ignore it. In making a change-over to gas only the best apparatus should be installed, because, though it was probably more expensive, it would undoubtedly show better results in the long run. Periodic inspection and attention should always be given.

Mr. Sawers had said that an industrialist with a high summer load and a low winter one should be given a special rate, and in this connection Mr. Poulson said that he would refer members to a paper on this subject which had been given to the Institution last year by Mr. Curtis, of Macclesfield. Mr. Poulson agreed with Mr. Sawers that the lowest price for gas should not be lower than the price into the holder. In Falkirk the net cost of gas into the holder was 2·630d. per therm and the lowest price was 2·924d., which was approximately 10% above the net cost. This was a very interesting figure. In view of the difficulty in persuading manufacturers to make the change-over from other fuels to gas due to the necessity of either scrapping or converting existing plant, Mr. Poulson suggested that the change-over of plant should be done by the supplying undertaking and be paid for by a slight increase in the price of gas.

Mr. STURROCK (Greenock) remarked that he was disappointed that Mr. Sawers had not given prices in his comparison of different fuels. It would be useful if he could give figures for the actual saving which had resulted from the change-over. In dealing with large-scale water heating Mr. Sawers had mentioned a special rate, and Mr. Sturrock wondered if this rate was outside the usual scale. In a conversion from solid fuel to gas it was very difficult to convince users that a saving was being made. In the Greenock district gas was being used by fish fryers and they had found this a very useful load. He thought that the cost of metal spraying would make it prohibitive for use on a holder.

Mr. WEBSTER (Port Glasgow), in regard to fuel in general, said it was surprising how little of the manufacturing cost was due to heat treatment. In many manufactures the cost of heat treatment was not great, and gas manufacturers were apt to place an exaggerated value on it. Any saving, no matter how small, was, of course, important. He would like to know the comparative price of oil. The baking load had been said to be common to every town, but this was not strictly true. Among the uses of industrial gas Mr. Sawers had omitted to mention the use of oxy-coal gas for metal cutting. He was impressed by the metallizing process and inquired what firms were using it.

Mr. CAMPBELL (Helensburgh) said that too much time was being spent in filching a load which might not be of very great advantage. It was the duty of gas undertakings to supply gas to the largest number of consumers at the lowest possible price. In Falkirk industrial gas was being sold at 2·924d. per therm, which represented a margin of 10% over the cost price. The ability to sell at this price depended on the returns from the residuals, and he was afraid that this price was too near the actual production cost. The saving mentioned as having been effected in supplying a works with 29 million c.ft. would not always be obtained, as works would not always be so conveniently situated as these must have been.

Mr. MCLAREN (Newton-on-Ayr) asked the size of the bath which had been described, as he had had inquiries for plunge baths which he was following up at the moment.

Mr. BATEMAN (Kilmarnock) said there was induced draught on the gas-heated boiler, and he wondered if the blowers were driven by electricity. If this were so then a breakdown might have a serious effect. It did not seem good policy to use both gas and electricity, and a small steam turbine would have been better.

Author's Reply.

Mr. SAWERS said that the industrial salesman must have a knowledge of the industries in his district, and therefore different knowledge was required for different districts. He had had no experience of crucible furnaces, but he knew that the installation of a tangential burner had been a great success as it had already saved the cost of installation. The chief factor in the cost of metallizing was the preliminary sand-blasting, which cost about ¾d. per sq. ft. There was no necessity to paint a metallized surface, as the aluminium formed an alloy with the steel. He agreed that only the best appliances should be installed, and they would prove a good advertisement for gas. The suggestion that the cost of installation should be paid by a slight increase in the price of gas and that the installation should be done by the undertaking was a good idea. The price of the oil used in the tests given was 3½d. per gallon, and this price was probably low, for large quantities of oil were used. In this connection not only the price of fuel had to be considered, for with oil there were a large number of "wasters." Perfect combustion was not obtained and drops of oil fell on the articles being treated. The expense of cleaning had also to be considered.

The gas supplied for heating the baths was charged at a price 2½% below the lowest figure on the scale, but this was still within the production cost, and as the consumption was 10 million c.ft. per annum the profit was quite good even if the percentage was small.

Change-over to gas resulted in better quality in the finished articles, and the labour costs were reduced because gas did not require the attention which coke demanded. He had had little experience in supplying gas for fish frying, because the fish fryers could not be persuaded to scrap their existing system. In assessing heat treatment costs many factors had to be considered apart from the cost of the fuel. Labour costs consequent on heat treatment might be high with other fuels and temperature fluctuations might be serious. He had had no experience in the use of gas for metal cutting, but metallizing was being used by R. & A. Main, Ltd., in producing high-grade gas burners. The Falkirk Iron Works and others were using this method for filling up blow-holes. He did not agree that too much time was being devoted to industrial gas. This field might only show a small percentage profit, but it was a good advertisement for gas, and they should not stand aside and allow competitors to take this load from them.

The size of the bath for which the water was heated by gas was 75 ft. by 45 ft., and its capacity was 94,000 gallons. The boiler worked at 20 lbs. per sq. in., and the blowers for induced draught were driven by an electric motor. It would require a long breakdown in the electricity supply before any damage was done.

Legal Intelligence

A "Gasrad" Installation

£900 Damages Against Mr. A. H. Barker

In the King's Bench Division, Mr. Justice MacKinnon heard an action in which Mr. Charles Taylor, of the Basil Hotel, Knightsbridge, sued Mr. Arthur H. Barker, of Victoria Street, Westminster, S.W., for damages arising out of an agreement by which, the plaintiff asserted, Mr. Barker acted as his Consulting Engineer in connection with the installation of a "Gasrad" heating system in his house. Plaintiff asserted that Mr. Barker was negligent in his advice and in his duty to him, and that the installation was not a success.

His LORDSHIP, giving judgment, said he considered that the system was in the experimental stage and was unsuitable at the time of installation (January, 1929) for a private house. Plaintiff was, therefore, entitled to recover the cost of the installation and removal. He awarded Mr. Taylor £900 and the costs of the action.

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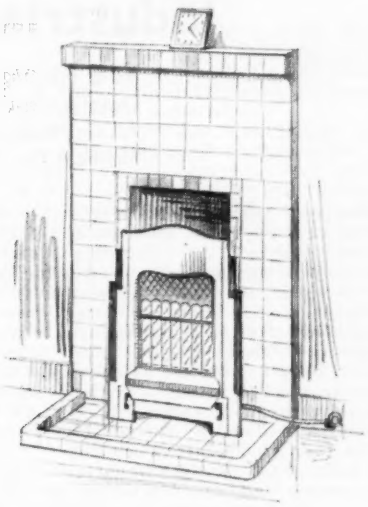

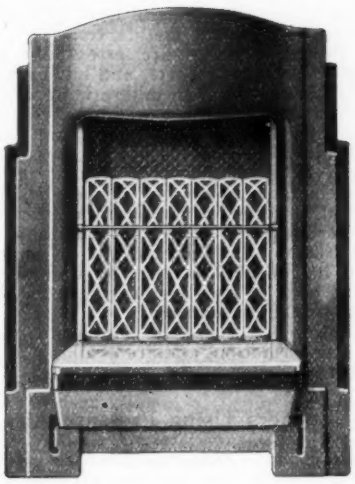

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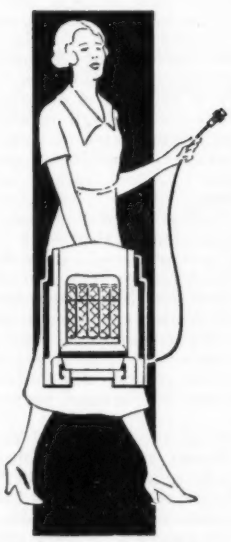

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GENERAL ASPECTS OF
Industrial Heating by Gas

by
Dr. H. A. FELLS

At a meeting in Leeds of the Yorkshire Industrial Gas Development Centre on Feb. 5, Dr. H. A. Fells, B.Sc., A.I.C., Ph.D., Chief of the Fuel Research Department of the Sheffield Gas Company, discussed this important subject.

Interchange of knowledge and experience, the main purpose of the Centres, is the quickest and cheapest way for mutual improvement. As different gas undertakings are never in competition among themselves for the sale of gas, there is no reason on that score why information should not be freely shared. There are certain cases, however, of gas being used for a particular industrial process, when it is not easy or advisable to give much detail of practical application, since our success as individual undertakings is dependent to a large extent on our discretion concerning these manufacturers' processes. Such cases, however, are not common, and in no way detract from the general usefulness of the Industrial Centre's scheme.

In the area of any one gas undertaking there are many different trades and manufacturing processes requiring their own specific forms of heat application. These heating processes may usually be carried out with any fuel with certain degrees of success; but it is our purpose to show that of all the fuels available, none is as efficient in the broadest sense as is town gas, in the majority of cases. It is a knowledge of the overall efficient use of gas which forms the basis of industrial heating development, and this knowledge is of necessity very varied.

Where fuel costs are small compared with the total manufacturing costs, such as cost of material being heated, charges for labour, and charges for necessary work after heating, then a fuel having a relatively high thermal cost can readily be considered, owing to the overall efficiency and process conveniences attainable. When fuel cost is a high proportion of the total manufacturing cost, such as in very large scale steam raising and production of electrical power, then it is usual to consider fuels having a low thermal price. For the purpose of this paper, however, I do not propose to introduce the complex question of tariff rates, but to confine attention to certain technical and practical aspects of combustion and application of heat.

Atmospheric Burners.

This class of burner uses gas at normal town pressure from 2-10 in. W.G. and is characterized by the fact that only a part, usually about 40%, of the total air required for combustion is drawn in by the momentum of the gas stream issuing from the orifice. Since atmospheric burners operate best when the highest possible gas pressure is maintained up to the air mixer, it is advisable to use gas pipes, valves, cocks, &c., of such size as will not cause any pressure drop.

The air necessary to complete combustion is added as secondary air. The amount of secondary air should be under definite control and should be kept at a minimum to ensure high combustion efficiency. The distribution of secondary air is obtained in various ways, the flames themselves often acting as inspirators. Double-chambered burners having an air duct around the burner ports, a separate air duct from the side of the furnace, &c., are quite common.

Most appliances in use to-day utilize secondary air admission ports which are much larger than is necessary, and it is advisable to have a damper arrangement to the exit products flues which can be mechanically controlled with the gas valve. This is not only a safety device to guarantee that the damper is not shut when the gas is turned on, but when the gas is off, the damper is closed and there is practically no flow of air through the furnace causing too rapid cooling. In a recent paper presented by Mr. W. Dieterichs, of the Gas Light and Coke Company, to the Southern Association of Gas Engineers and Managers, a new simple form of diaphragm operated flue damper control is mentioned as being satisfactory and should soon be on the market. Apart from being a safety device, it reduces the flue area in proportion to the gas rate, and naturally is conducive to the production of higher efficiency.

Atmospheric burners are no doubt used to a greater extent than any other form of burner, especially for domestic appliances, and the same principles are employed in industrial atmospheric burners as in domestic burners. In industrial applications, however, greater use is made of special adaptation of atmospheric burner design, such as single nozzle burners, ring burners, and bar burners.

(*a*) *The Single Nozzle Burner.*—This is virtually a bunsen burner, usually with a special system for admitting secondary air. They have a very wide application for bakers' ovens, core-drying ovens, air-heaters, immersion heaters, boilers, low-temperature heat treatment furnaces for ferrous and non-ferrous metals, &c.

(*b*) *Bar Burners.*—These are essentially pipes, bored with a number of holes or ports, and having a gas-air mixing chamber at one end. In determining the best size of pipe for a particular number and diameter of ports, to maintain even lengths of flame at each port, and to prevent flashback, it is usual to have a pipe of cross-sectional area not less than 1½ times the total area of the ports. The supply of secondary air to bar burners should be given attention, and a successful method in a closed apparatus is to have a second pipe, bored with suitable sized holes, immediately below the bar burner, to supply the air. Atmospheric bar burners have a very wide field of application, and can even be used for heating from above as with platens in the Bakelite industry.

(*c*) *Ring Burners.*—These are similar to bar burners in concentric ring formation, and are available in various sizes for many forms of open heating operations.

Burners Using Pressure Air.

(*a*) *Nozzle Mixing Burners.*—The use of low-pressure air as supplied by a fan, and not exceeding about ½ lb. pressure, in conjunction with gas at town pressure, is a very common system of combustion. The air and gas do not mix until they reach the outlet of the burner, and the type of flame produced is large and usually luminous. Their greatest advantage is that they have an almost infinite turndown range, since they cannot flash bask. The ratio of air to gas can be controlled by separate valves, or by means of simultaneously operated valves actuated by a single control. It is also possible to use governors in such a way that the gas flow is proportional to the air flow.

This class of burner is very valuable, for several reasons. Both gas and air are under pressure and can be separately or simultaneously controlled; the type of flame can be altered from completely luminous to well aerated, with consequent alteration in flame length and heat dispersive capacity and composition of products of combustion for atmosphere control purposes; and finally, this class of burner is probably the best for use in processes where heat salvage by recuperation or regeneration is to be used. In fact, one of the most recent developments in burner design and application is the system of combustion known as "Diffusion Flame," details of which it is proposed to give later in this paper. Applications of nozzle mixing burners are particularly varied, including metal melting, burning of bricks and refractory materials, melting of glass, heating for forging, reheating of steel billets, annealing, galvanizing, and boiler firing.

(*b*) *Burners Supplied with Pre-mixed Gas and Air.*—It is with this type of combustion system that very high rates of heat input to furnaces are obtained, with consequent increase in the degree of temperature attainable in a small space. Probably more attention has been given to applications of these types of burners of recent years than any other, since they allow tremendous scope for such features as perfect combustion, rapid heating, high temperature, control of combustion, single cock control, control of temperature, maintenance of furnace pressures, and general adaptability.

It is customary to use air at not less than 1 lb. pressure supplied by a suitable design of fan or blower. The simplest system is to use a burner not unlike a blow-pipe, with an air tube concentrically placed in a gas tube, attention being given to the respective tube sizes. By means of valves to both gas and air supplies, a very satisfactory degree of combustion can be obtained at a wide range of settings without back-firing, owing to the high mixture velocities. It is often said that such burners as these are not to be advised, owing to the possibility of air exerting

a back pressure to the gas supply, but such burners have had very extensive use in the steel trade.

The modern types of pressure air burner, however, have many valuable features and make use of the true venturi injector principle. A stream of air passing through a venturi tube perforated at or near the throat by holes leading to a gas chamber, draws in a quantity of gas. The gas chamber is supplied with gas at atmospheric pressure, controlled by an atmospheric pressure governor. The amount of gas drawn in by the air is dependent upon the velocity of the air stream, and unless controlled, can be in excess of the amount possible to burn completely. A regulating valve is used to control the actual amount of gas drawn in, and once any particular setting has been made, this valve can be locked and the air-gas ratio remains constant over a fairly wide range. Single-lever control of the air supply is then sufficient to control both the quantity of air and gas. The turbulent flow attainable by this venturi system causes rapid mixing of the gas and air, and thus increases the speed of combustion. The high mixture velocities resulting necessitate suitably designed burner nozzles and throats to prevent the flame leaving the burner. A mixture of gas and air prepared in this manner can be supplied to one or several burner nozzles through a manifold, maintaining even pressures to each nozzle. The pressure, measured in inches Water Gauge in the manifold can be used as an approximate indication of the temperature. The heat input possible by this type of burner is roughly ten times as great as that used for domestic purposes, per square inch of burner port, and consequently such burners require very much less combustion space than do the other types of burners mentioned.

This method of mixing gas and air and supplying it at high velocity enables certain features to be obtained in practice which otherwise would be very difficult. When such a mixture of gas and air is caused to impinge on a bed of broken incandescent refractory material, the phenomenon known as surface combustion is produced, which in effect is simply to increase still further the rate of combustion. The impact method of firing has very wide application in modern industrial heating, since a very high percentage of radiant heat is possible, and direct flame impingement on work being heated is avoided.

(c) *High-Pressure Gas Burners.*—When gas at 3 lbs. pressure is used with a properly designed venturi mixing device, it will inject all the air necessary for complete combustion, and such a system is incorporated with several types of burner and method of application to furnaces. The facts that high-pressure gas injection of air requires only one feed system, that any desired gas-air ratio can be obtained by primary injection, that high thermal input per cubic foot of combustion space is possible, and that flame size can be reduced to a very small minimum, allow particularly varied applications of gas heating.

In addition to general furnace work for reheating, and for metal melting, this system is often used for bar burners having circular, slotted or ribbon ports, for use in plastic presses, vulcanizing presses, and gramophone record presses—*i.e.*, for heating platens and dies. Also for glass working, Neon tube bending, and all purposes where very localized heating is required. The principal disadvantages of high-pressure gas burners are:

(1) High initial and maintenance costs of compressor plant.
(2) Necessity for careful control to maintain flame stability.

With both high-pressure air and high-pressure gas injection, the problems of instability of flame and limited volume range have called for the introduction of multi-stage injector burners, but these burners usually call for a high degree of practical skill on the part of a furnace operator. Considerable attention has to be given to maintenance of pressures and to adjustment of injector settings, and unless care is taken, trouble is experienced due to incorrect gas-air ratios and back firing.

(d) *Pressure Air-Gas Mixtures.*—Other systems of mixing of gas and air are available, when gas and air mixtures in non-explosive ratios are produced and used as injecting media in a similar manner to high pressure gas. In some instances a mixture of gas and air in proportions for complete combustion is produced and supplied direct at high pressure and velocity, but can only be used with suitable care against leakage and possible explosion. These latter methods, although being independent of varying gas and air pressures, are costly, but find use in certain special processes such as require very localized heating, as, for example, in the manufacture of electric bulbs, cloth singeing, and the heating of calenders for cloth finishing processes. The use of special premixing plant, using both compressed gas and air, has useful application for industrial lighting of mills, workshops, and factories, especially when the trouble of fluff being drawn into gas mantles detracts from the value of ordinary gas lighting installation.

Special Burners.

The excellent adaptability of gas to many methods of combustion will probably have been indicated in the foregoing general account of burner systems; but I should like to refer to one or two special methods of heat production before leaving the question of burners.

Surface Combustion.—When gas is burned by any of the methods described the flame produced is, under ordinary circumstances, non-luminous, and the heat liberated is conveyed to surrounding materials largely by the process of convection. As heating by radiation is known to be much more rapid and generally desirable, it is apparent that to combine the high percentage conversion of latent heat of town gas into sensible heat by perfect combustion and the rapid distribution of heat by radiation would result in very efficient utilization of gas. There are two practical methods of obtaining this combination, using a phenomenon known as "surface combustion." The initial factor is the production of a correctly proportioned homogeneous mixture of gas and air by any of the suitable methods already described. Instead of allowing this mixture to burn freely at a nozzle, it can be used in either of two ways.

In the first method, the one originally used in developing this system of combustion, the gas-air mixture under suitable pressure is caused to pass through a porous refractory diaphragm or plate. On first lighting the mixture as it issues from the surface of the diaphragm, flame is produced, but rapidly disappears, leaving an intensely glowing surface of the hot refractory diaphragm. Although no flame can be seen, rapid combustion occurs in the top $\frac{1}{4}$-in. layer of the refractory diaphragm. By this method the power of accelerating gaseous combustion by the catalytic effect of a heated surface results in flameless combustion.

The practical effect of this system may be summarized as follows:

i. Combustion is very greatly accelerated.
ii. Combustion is perfect.
iii. The amount of radiant heat developed allows very rapid heat transmission to material.
iv. The radiant surface can be used at any angle, even facing downward.
v. The combustion space required is exceedingly small.

This system, as originally devised, is seriously limited in practical application by the inability to obtain refractory diaphragms capable of withstanding the very high temperatures which can be produced, and at present is limited to processes using temperatures less than 950° C.

The second system, a modification of the first, is, however, of very wide application. Reference was made to this system in describing the application of pressure air injectors to furnace heating by the impact method. The bed of broken refractory material can be made of the highest quality refractories available, such as aloxite, fused magnesite, or zirconia brick, since they do not need to be prepared of special sizes, grouped and bonded as when a diaphragm is used. The prepared mixture of gas and air issues from the burner opening at a speed greatly in excess of the ignition velocity, and burns on the surface of the incandescent refractory. Radiant heat is consequently produced, and is a very high proportion of the total heat input. The shape, location, and distribution of the refractory bed can be widely varied, and the radiant heat directed as desired. This method of combustion has been applied to such diverse processes as metal melting, varnish heating, galvanizing and tinning baths, steam raising, forging, and heat treatment of metals and solution heating.

Submerged Combustion and Immersion Heating.

Submerged combustion in one form is really a further adaptation of surface combustion. The acceleration of the rate of combustion at the surface of a refractory diaphragm is so great that it will even take place under water, and certain burners are on the market which can actually be used submerged in water. The heating efficiency by this method is particularly high, since the latent heat value of the water formed by combustion is available. Oxy-coal gas steel cutting burners, where very high mixture velocities and pre-mixed gas and air are used, can also be used under water, and rely on the pressure exerted by the products of combustion keeping back the water in a suitably designed burner head.

Immersion heating is really carried out by causing combustion to take place in a chamber of suitable design which can be submerged, and having a flue partly submerged, so that the highest possible efficiency can be obtained. Practically any form of burner can be used in this process,

from the atmospheric type to those using pre-mixed gas and air, for purposes of solution heating and stereotype metal melting.

The foregoing general description of everyday forms of burner equipment has been given to show the degree of scientifically accurate control it is possible to reach when using town gas in the production of heat. Not only can efficient and economic combustion be assured, but the methods employed to this end can be subjected to numerous control and indicating devices, using precision instruments such as pressure and flow indicators and controllers, temperature indicators, and temperature controlling devices. The control of combustion and the many instruments and methods which are used so extensively to-day for this purpose are, without doubt, the main reasons for the rapidly increasing field of application of town gas for all forms of industrial heating.

Although industrial burners have been described as a separate feature so far in this paper, and although it is appreciated that a sound knowledge of burner equipment is necessary, they must in practice be considered as integral parts of the furnace, or oven, or heating plant to which they are attached. Many factors influence the choice of burners for any operation, and many factors affect the functioning of a burner when working in an industrial unit. Some of these factors to be considered are:

i. The maximum burner capacity.
ii. The rate of heating.
iii. The temperature.
iv. The distribution of heat.
v. The type of temperature control.
vi. Atmosphere control.
vii. Safety devices.
viii. Waste heat recovery.

Rather than attempt to show in detail how these various factors are approached and considered, a list has been prepared and included in this paper giving a fairly wide variety of heating processes, and including for the purpose of ready reference the temperature range required, the gas mixing systems, the type of burners, the application, the type of air supply, the method of combustion control, the type of temperature indicator, and the type of atmosphere. Although in each case a number of alternatives is given, the final choice has to be made on a study of the economics of the problem as influenced by general plant conditions, equipment already available in the works, and possible future development.

Method of Approach.

Having given some account of the methods of combustion of town gas and the types of burner appliance available and in addition referred to the more important initial items which require careful attention in the application of gas, we may consider how industrial heating by gas may best be approached. The Gas Industry to-day is in the happy position of being able to call upon many manufacturers for all forms of burner appliances, heating plants, furnaces, instruments, &c., and standard types of equipment are numerous. But manufacturing processes have become so involved, and the demands of engineers have become so exacting, that before a new gas appliance can be installed in a works very convincing figures and process conveniences have to be given. Although for many processes standard and approved forms of appliance can be recommended and bought direct from manufacturers with a certain degree of guarantee of performance, it is undoubtedly advisable for a Gas Undertaking to have one or more men who are capable of assessing fuel values for any process, and of proposing particular applications of gas and design of heating plant.

Suppose a firm is approached who carries out the heating of steel by solid fuel, and it is desired to convert the furnace to gas firing, or to install a new furnace. The first problem is—how much gas will be required to do the job? There are several ways of determining this. Direct calculation based on the temperature required, the period of heating, the size of combustion space to accommodate the load being heated, the weight of the load, the mean specific heat of the metal, the maintenance consumption of the furnace, &c. Such calculations are used by furnace designers, but experience makes it possible to arrive at a figure by more simple, if not such accurate methods. A simple method is to find the amount of solid fuel of known calorific value required per unit weight of material being heated, and to calculate the amount of gas of equivalent B.Th.U. content. It is then fairly safe to assume that a properly designed gas-fired furnace will have an efficiency about three times that of the solid fuel furnace, and by simple calculation the amount of gas required can be determined. This first approximation is then checked from a knowledge of the possible B.Th.U. input per unit volume of combustion space in a gas fired furnace, incorporating either natural draught or pressure burners. The use of natural draught or pressure burners is determined by the temperature required, the type of heat distribution necessary, and the type of process, &c., and, in a general way, natural draught burners are used for temperatures up to about 1,000° C., and pressure burners for temperatures higher than 1,000° C.

It is not yet possible to calculate with certainty the size of combustion space necessary for complete combustion of a particular volume of gas burned in a specific manner, neither is it possible to know with certainty the actual B.Th.U. input per unit volume of combustion space; but by observation of furnace performance, a good practical understanding can be obtained. It is easier to base these calculations for quick assessment purposes on the experience previously gained, of attainable temperatures on known hearth areas by known gas consumptions of any method of burner application and type of combustion. Existing furnaces are designed to have a heat input of 25,000 to 80,000 B.Th.U. per hour per c.ft. of combustion space, but it is possible to use higher rates than this.

Knowing the probable maximum gas consumption per hour determines several factors—namely, the size of gas supply main to the furnace, the size of the meter, and the capacity of a fan or blower if pressure air is to be used, or the size of gas compressor if high-pressure gas is to be used. A knowledge of the amount of gas required per hour, the temperature to be reached, and the distribution of heat necessary, determines the type and number of burners to be used. These essential factors are not as difficult to determine in practice as a recital of them would suggest, and, once obtained, the design of the furnace itself has to be considered; but the main fact is that the efficiency of heating by the combustion process and design of furnace adopted is well known from experience and calculation. On this efficiency the cost of heating by gas at a known thermal price can be determined. On such figures of actual cost of fuel, charges for a new furnace or for a converted furnace, and installation, a proposal can be made to a manufacturer.

Burner Capacity.

A word or two about the burner capacity may be helpful, since this is usually found to be a difficult problem, for certain reasons. The maintenance consumption of a furnace determines the minimum size of the burners, but the consumption required for heating up purposes is usually very much higher. Naturally, the maximum sized burner has to be fixed for the maximum heating rate, but it is important that the burner must be capable of sufficient turn-down for the maintenance consumption without back-firing.

This point is particularly important when using pre-mixing burners supplying properly proportioned gas-air mixture to one or more burner nozzles, and makers of appliances of this type make different burner sizes for particular temperature ranges. Similar precautions are necessary when a furnace is designed to work at more than one temperature. It will be realized then that an ability to estimate the gas consumption in the first place is of paramount importance.

Although the example just given concerns a steel heating furnace, other processes need to be similarly considered for the possible gas consumption in the first place, and each process needs to be given individual attention since other factors having a bearing on the total gas consumption usually arise. For instance, the quality of refractory and insulating material used in building the furnace, the use of waste heat recovery systems, the type of furnace atmosphere required, specific and latent heats, &c., all have their individual and collective influence on the gas quantity to be used, and hence on the many other factors described. The type of refractory and amount of insulation goes hand in hand with burner selection, and a knowledge of the properties of refractories is very valuable for conversion and repair work on furnaces. Such items as rapid heat transfer, low co-efficient of expansion, mechanical strength at high temperatures, resistance to abrasive and slagging action with metallic oxides, and refractoriness, need to be given thought.

I wish to mention a few points about waste-heat recovery and atmosphere control in a general way, as they are becoming necessities to-day rather than refinements.

Waste-Heat Recovery.

The recovery of heat normally wasted in the flue gases is not the simple process one might at first imagine. Roughly 60% of the potential heat in the gas burned in a furnace is lost in the flue products, and the practical difficulties encountered in attempting to recover all or part of this heat are great. The commonest methods employed are pre-

heating the ingoing material, pre-heating the air used for combustion by recuperation or regeneration, and where steam is used, waste-heat boilers may be used with advantage. A more recent method developed particularly in America is the recirculation of flue gases.

The main method used to pre-heat ingoing material is to employ the counter-flow system, the material being charged into the end of a furnace farthest removed from the burners, and being progressively heated by the waste gases as it travels the length of the furnace. Such a system is valuable for high rates of production and continuous processes, and in one steel billet heating furnace in Sheffield using this system a heating efficiency of 52% has been obtained, and a normal working efficiency every day of 40%. This system allows the use of almost any type of burner, and only requires special furnace arrangement. The preheating of the air for combustion is a more complex matter, for such reasons as the life of the recuperators, or regenerators, the high initial cost, the increased rate of flame propagation and its consequent effect on burner design. This latter effect is so great that it practically precludes the use of pre-mixing burner systems, and cannot be used normally with high-pressure gas systems.

Pre-heated air is almost confined to use with nozzle mixing burners, when the gas and air are separate right up to the point of flame production. With recuperation, the air is heated by being passed through either refractory channels or metal tubes, the hot flue gases circulating round them and in the opposite direction to the air. Very simple forms of recuperators can be designed consisting of single tubes of small diameter built in the flue channels themselves, passing the air at a sufficiently high speed to obtain turbulent flow. In very large furnaces, such as are used for heavy billet heating for rolling or forging, either simple recuperation or regeneration is employed. In regeneration, the alternate heating of brick checker work by flue gases and cooling by air is employed, suitable reversing gear being used, which can be either hand or automatically operated.

It is almost universal practice with such furnaces to use separate air and gas supplies, as already mentioned. With properly designed recuperators and regenerators it is possible to obtain particularly efficient heating, even as low a gas consumption as 1·7 c.ft. of gas per pound of steel heated to 1,300° C. being readily attainable.

The use of waste heat boilers is not common, as the load factor of the boiler must be considered in relation to the load factor of the furnace. Waste heat boilers involve very complicated economics, and in themselves are not usually very efficient.

Atmosphere Control.

Practically since the early days of the use of gas for industrial heating, especially in the metal industries, gaseous products have been claimed to be capable of exerting a protective effect during the heating process. We are all well aware of the oxidizing, neutral, and reducing atmospheres, which it is claimed can be produced by combustion of gas, and without doubt, this fact has proved a very valuable one in many processes. Of more recent years a tremendous amount of research and attention has been given to processes of atmosphere control, and to-day the results of this work are adding tremendously to the value of gas in industrial work of all kinds.

In fact, there are some applications of gas which from the point of view of heating efficiency, are particularly low, but, the overall efficiency of the complete manufacturing process is so greatly improved, that simple thermal efficiency is almost forgotten. Atmosphere control is very closely linked with combustion control, and it is certain that no fuel known is so valuable where chemical processing of metals during heating is required as is town gas, owing to the control possible with the combustion. Future uses and application of gas will expand rapidly on a proper understanding of atmosphere control, which is based primarily on a thorough knowledge of the chemistry of combustion and gaseous reactions.

All large firms employ a fuel technologist; small firms cannot afford one. The industrial gas salesman should be capable of acting as fuel technologist to these small firms, and be able to bring to their notice existing modern heating plant, or be able to show how a proper use of gas can

Usual Combinations of Gas Equipment for Industrial Processes.

Operation.	Temp., ° C.	1 Gas Mixing Systems.	2 Burners.	3 Air Supply.	4 Temp., Instruments.	5 Control Systems.	6 Atmosphere.
Solution heating	−100	C, D, H	2, 6	N, H	f, g	V., VIII.	n
Boiler firing	per pressure	G, H	5, 6, 7	N, L	h	III., VII., VIII.	n
Bread baking	175–290	A, B, C, H	6, Special	N, M	f, g	I., II., V.	n
Varnish boiling	270–320	B, C, D	3, Special	N, M, H	f	I., II., V.	n
Platten heating	−150	A, B, H	8, 4, 6, 7	N, M	d, f, g	IV., V.	n
Cloth singeing	..	A, B	4, 6	N, M	..	..	n
Vitreous enamelling	650–870	B, C	1	N, M	d	I.	o
Japanning, &c.	90–260	C, N	1, 6	N, M	g	I., II., V.	o
Core drying	180–260	B, C, D, H	3, 6	N, M, H	g	I., II., V.	o
Burning, pottery, refractories	1,300–1,500	G, H	2, 5, 6	N, L	b, c, Cones	I.	o
Annealing, open furnace	600–960	C, G, H	4, 5, 6	N, L	d	I.	n, r, c
Box or pot annealing	600–960	C, G, H	4, 5, 6	N, L, M	d	I.	n
Glass annealing	350–830	C, B, H	1, 2, 4, 6	N, L, M	d	I.	o
Carburizing	870–950	A, B, C, D, H	1, 2, 4, 6, 8	N, L, M	d	I.	n, Special
Nitriding	500–570	A, B, C, D	1, 2, 8	N, M, H	d, e	I.	Special
Hardening open furnace	750–1,360	A, B, C, D, H	1, 2, 4, 6, 8	N, L, M, H	a, b, c, d	I.	n, r, c, Special
Hardening baths	750–1,300	A, B, C, D, H	1, 2, 4, 6, 8	N, M, H	d	I.	n, r
Tempering	150–600	H, C, D	6, 1, 2	N, L, M	g	I., III.	n
Heating for forging	1,000–1,300	B, C, D, G	1, 4, 5	N, L, M	c, d	I.	n
Cutting and welding	1,150–1,600	F	5	Oxygen	h	VII.	o, r
Melting steel and alloys	1,400–1,700	G, D	5, 1	N, M, H	a, b	I., Special	r
Melting brass, copper, nickel silver, &c.	960–1,350	B, C, F	1, 5	N, M	d	..	r, n
Stereotype melting	340–370	A, B, C	1, 8	N, M	d, e	I., II., IV.	n
Electrotype melting	340–360	B, C, D, H	1, 3, 6	N, M	d, e	I., II., IV.	n
Aluminium melting	710–760	B, C, D, F	1, 2, 4, 5	N, M, H	d	I.	n
Zinc for galvanizing	430–455	B, C, G	1, 4, 5	N, L, M	d, e	I.	n
Glass melting	1,260–1,480	G	5	1	b	..	n

EXPLANATION OF SYMBOLS USED IN EQUIPMENT TABLE.

Column 1. Gas Mixing Systems—
- A. Central station, premixers
- B. High-pressure gas, 1 and 2 stage.
- C. Low-pressure air proportional mixers.
- D. High-pressure air proportional mixers.
- F. High velocity nozzle mixers.
- G. Low velocity nozzle mixers (luminous).
- H. Atmospheric.

Column 2. Burners—
1. Tunnel, impact.
2. High velocity.
3. Refractory tipped blast burners.
4. Combination proportional mixers.
5. Nozzle mixers.
6. Atmospheric.
7. Atmospheric, multi-jet and ribbon.
8. Special for pre-mixed gas and air.

Column 3. Air Supply—
- N. Natural draught or atmospheric.
- L. Low pressure, fan up to ½ lb.
- M. Medium pressure 1–3 lbs.
- H. High pressure over 3 lbs.

Column 4. Temperature Instruments—
- a. Optical pyrometer.
- b. Radiation pyrometer.
- c. Rare metal thermocouple.
- d. Base metal thermocouple.
- e. Low temperature resistance thermocouple.
- f. Glass thermometers, &c.
- g. Gaseous or liquid extension thermometers.
- h. Pressure gauges.

Column 5. Control Systems—
- I. Electric motorized valves.
- II. Compressed air.
- III. Diaphragm (gas or liquid actuated).
- IV. Expansion rod, solid.
- V. Bulb expansion.
- VI. Bimetallic rod or spring.
- VII. Pressure regulators.
- VIII. Liquor level controllers.

Column 6. Atmospheres—
- n. Neutral or complete.
- r. Reducing, excess gas.
- o. Oxidizing, excess air.
- c. Carburizing, raw gas.

Special—
- Nitriding—Ammonia.
- Carburizing—Cracked raw gas *plus* a diluent.
- Hardening—Raw gas; cracked raw gas, cooled waste products *plus* raw gas: cylinder gases such as nitrogen, and trade specialities like electrolene, pyrofax, butane, &c.
- Bright Annealing—
  Cracked raw gas, cylinder hydrogen and nitrogen, cracked ammonia, methanol, &c.

enable them to carry out their individual manufacturing processes in a simpler, cleaner, and more efficient manner.

These matters, simplicity, cleanliness, and general manufacturing efficiency, are far more important than mere comparisons of initial fuel costs and thermal efficiencies in most industrial processes using heat. A knowledge of combustion, practical, physical, and chemical, with an equal knowledge of the requirements and manufacturing details of the local trades, constitute the stock in trade of the industrial gas salesman.

Discussion.

Mr. H. SINGLETON (Huddersfield) moved a vote of thanks to the lecturer, and Mr. C. R. INGHAM (Brighouse) seconded the resolution.

Mr. E. A. LEASK (Leeds) said that Dr. Fells had referred to a normal town pressure of 2-tenths water gauge. He would like to know what the speaker's opinion was of the pressure suitable for use with domestic gas appliances. He thought a pressure of about 4 in. was very desirable for that class of work, though in many districts where industrial works were situated such a pressure was not desirable. In regard to the manufacture of electric lamps, complaints had been made of a stain inside the bulbs. Considerable effort had been made to discover the cause of the stain. There had been consultation with the Leeds University regarding the matter, and the University inquirers had come to the conclusion that the stain was not due to any impurity in the gas, such as sulphur. Dr. Fells had not referred to central heating, which was now regarded as an industrial problem, and in regard to which there were some difficulties. There was, for instance, a great deal of trouble with condensation in flues. Large quantities of gas were consumed in the central heating boilers, and there was the possibility of large quantities of water in the flues. Then there was the question of corrosion of the flues. What was the right material? He thought that the old earthenware or porcelain-lined cast-iron flue might do. But it would be expensive.

Dr. FELLS suggested that to maintain 3-in. pressure in the service at the point where the gas was to be used would be found to be fairly useful. They could govern down to 2 in. if necessary, but he would say that 3 in. was the figure to be aimed at. A particularly interesting point mentioned by Mr. Leask was that relating to the staining of electric bulbs. He had had no experience of the particular instances mentioned by Mr. Leask, but had had acquaintance with work done in connection with the staining of bottles and other glassware. Up to a point they in Sheffield had been of the mind that sulphur was the cause of the staining, but it proved that that was not so, but that the bottles were affected by the strength to which they were annealed. The use of porcelain or lined flues would be advantageous in certain respects, but might give rise to other difficulties.

Mr. J. T. HAYNES (Rotherham) said that in regard to the central heating trouble they had found in Rotherham that if they had a break in the flue so that the products of combustion were diluted, the disadvantage was negligible.

Mr. A. W. FIELD asked whether it was a fact that with any form of heating 100% efficiency could be obtained.

Dr. FELLS replied that the highest efficiency figure that had been recorded in relation to an electrical furnace was 80%. No matter what fuel was used a certain amount of circulation of air caused loss of heat.

Mr. J. W. WOOD (Leeds University) spoke on the work he was doing for the Institution of Gas Engineers on the effect of sulphur compounds in combustion products on the corrosion of gas appliances.

The vote of thanks to Dr. Fells having been passed, the meeting ended.

RECENT DEVELOPMENTS IN

The Construction of Dry Meters

by
A. KNIGHT

In a Paper before the Midland Junior Gas Association on Feb. 7, Mr. A. Knight, Superintendent of Meter Shops of the Birmingham Gas Department, described the improvements which have been effected in the construction of dry gas meters during recent years.

During the past 20 years there have been many efforts to bring the straight reading index into prominence, due to the simplicity of its reading and the advantage it gives to the consumer in checking the states, but our experience tells us that this component is not so reliable as the old type of index. In the old type of index it is only a moment's work to spin the wheels round and check them for correct gearing and freedom. Again, when the meter is working, the whole train of wheels in the index is moving, and in consequence of this there is not the liability of binding.

This is not the case with the straight reading index; you cannot conveniently spin the index round to test for freedom and accuracy of gearing. The first wheel of the index has to make one complete revolution before the second wheel moves. The same applies to the other wheels in the index, so you can readily understand that it might be 6 or 7 months before the last wheel of the index moves. In consequence of this, corrosion sets up, binding the index, and in many cases they cease to register.

The idea of the straight reading index is good, but the index is such an important component that you cannot afford to run any risks.

In a correctly designed meter the registration should have practically no variation when passing a small quantity or when using (say) 100% above its badged capacity. This cannot be obtained unless great accuracy is observed, first, in designing the valve plate; secondly, in the design of the grids and covers; and thirdly, in the manner in which the leather is fixed to the meter.

It was not until a few years ago that a definite and general move was made to increase the hourly capacity of dry meters. The valves were altered very considerably, while their overall dimensions remained the same as before. The working surface was cut down to a minimum, which enabled the ports of the valves leading to the diaphragms and outside case to be made much larger, and the exhaust port was increased by 100%. This, of course, meant larger gas-ways throughout the meter.

These alterations have enabled us to produce a much smaller meter than the ordinary 5-light, and with a badged hourly capacity of 150 c.ft. and a maximum loss of 3-10ths water pressure at the outlet of the meter. At the same time our complaints have been very much reduced; furthermore, the registration is guaranteed by the Statutory Inspector's test and stamp.

Condensation.

In spite of all the good features concerning dry meters, there are troubles that are peculiar to these, one of the most frequent being due to condensation which accumulates in its interior. The amount of condensation varies very considerably in different situations, and appears to be due to variation in temperature conditions. In warm and dry situations, very little trouble is found to occur, but when the meter is subjected to changes of temperature, or when it is fixed in cold and draughty positions, then the trouble is experienced at its worst. In many instances we have had meters brought in to the works from the district, and, when opened for examination, they have been found to contain liquid sufficient to fill one-third of the case. This accumulation of liquid within the meter is a very serious hindrance to its proper working and correct registration. When condensation begins to form in the interior of the diaphragm chamber, it immediately tends to lessen the measuring capacity of the meter. The weight of water has a tendency to distort the leather and pull it from under its banding. When this happens the meter ceases to register.

Furthermore, the continuous presence of water and gas deposits has a very serious effect on the dressing of the leather, causing the leather to become hard and porous. This throws an extra strain on all the working parts, which is sufficient, in many instances, completely to stop the meter working. It is almost impossible to get the condensation out of the meter. The best we can do is to make holes in each of the outside cases, lay the meter on its side, and then re-solder them up: but to try to remove any deposits from the interior of the diaphragm by continually tipping the meter upside down has a very bad effect.

Where excessive condensation is the trouble, the meter should be changed as soon as possible.

Self-Draining Meters.

As a dry meter is otherwise such a convenient and useful type, it was in an endeavour to overcome these troubles that the self-draining meter was designed, and the first models made in our own meter repair shops. As the name implies, this design provides for the draining of any condensate which takes place within the meter to the inlet. I would like to state, at this point, that in all previous meters of this type the condensates drained to both inlet and outlet, but the valves have now been re-designed, and in consequence of this the liquor is all drained to the inlet. This does not permit of any liquid being retained, owing to the position and construction of the valves and the diaphragm chambers.

The valves are situated in the lower part of the meter and on the underside of the valve plate. They are of the double-piston type, and, in this respect, are quite different in construction from the ordinary kind of dry meter valve. The ports of the valve lead to the diaphragm and case chambers in just the same way as the ordinary flat valve, but there is this great difference—although the valves are in the lower part of the meter and therefore, in effect, are fixed upside down, they always permit of a free flow of liquid through them, but cannot come off their seating in whatever position the meter is placed. During transport one can rest assured that the valves cannot be displaced. This point in itself is quite an advantage, as transport is responsible for a great deal of trouble with the valves in the ordinary type of dry meter.

The meter has four distinct compartments. At the bottom is the valve chamber. On examination of the valve, it will be found that in the interior of the exhaust port there is a weir, and when condensates reach the height of the inlet port of the valve the piston acts as a pump and forces it out to the inlet of the meter. In the centre there is the usual divided compartment for the diaphragms, and the index chamber is at the top. The valves are not driven by a crank as in the ordinary dry meter, but are moved by arms attached to the extensions of the flag rods. The advantage of this construction is that the valves receive almost a straight line pull, thus ensuring perfect motion without any fear of binding.

Two small stuffing boxes between the valve and diaphragm chambers act as bearings for the flag rods; very little packing is necessary in these, as they are only subjected to differential pressure which, at nominal loads, does not exceed one or two-tenths water pressure. The diaphragms themselves are exactly similar in construction and arrangement to those in the ordinary meter. There is a slight modification in the actual gas-ways between the valves and the diaphragms. In the index chambers are housed the flag rods, stuffing boxes, top arms, tangent and spindle, cross shaft and index. It is interesting to note that no centre stuffing box is necessary; this is rather a peculiar advantage secured by the adoption of the straight line drive for the valves, and it gives all the benefits of a closed top meter without a centre stuffing box.

Many of the ordinary dry meters returned from the district have become defective owing to leakage in the top. An examination shows that it is the centre stuffing box which is at fault.

There is no necessity for explaining how the gas passes through and is registered, as it is precisely the same as in the ordinary meter. I would like to point out that where the service does not rise straight from the main to the inlet of meter, a syphon is required, but no syphon is required at the outlet.

You might be interested to know that we have recently made in our meter repair shops a 16,000 c.ft. per hour meter of this type. The valves are made of gunmetal and have an 8-in. bore. The valve plate was made of $\frac{7}{16}$ in. mild steel plate and the valves were supported by $\frac{1}{2}$ in. bars and $\frac{3}{8}$ in. bolts and nuts. The diaphragm leathers were 68 in. in diameter and all in one piece.

The frame of the meter was 2 in. tinned angle iron $\frac{1}{8}$ in. thick, and over 3,000 rivets were used in its construction. On the outlet was the usual meter neck, but the inlet had an 8in. screwed flange fitted. This was done to simplify the connecting and disconnecting of the meter. As you are all probably aware, when you disconnect a meter that has the usual meter necks fitted, it is a difficult matter to refix it again owing to the lack of room to make your joints, but in the method we have adopted, you simply release the back-nut of the pipe that is attached to the screwed flange and screw the pipe into the meter until you have sufficient room to pull the meter out. When you refix your meter, you make your outlet joint and unscrew the pipe that is in the interior of the meter back again into the inlet service and re-tighten the back-nut.

The weight of the meter when finished was 11 cwts. The capacity per revolution is 33·3 c.ft. When the meter was tested for soundness at 12 c.ft. per hour, it gave 33·33 c.ft., proving the absolute soundness of the valves. When tested at 2,000 c.ft. per hour, which was the largest consumption I could get with the test holders, it gave the same result, and the loss of pressure between inlet and outlet was 1-10th of an inch water pressure.

The meter was tested at 18,000 c.ft. with air (an electric blower being used). The difference between inlet and outlet pressure at this capacity was 7-10ths of an inch water pressure, and the action of the meter was perfect.

Straight Drive Meters.

From the drain meter there evolves the straight drive meter. This meter is fitted with the usual flat valve and is the same in construction as the ordinary dry meter with these exceptions. There is no centre stuffing box, no centre crank, and you cannot alter the timing of the valves by moving the position of the tangent on the spindle.

There are several advantages which can be claimed for this type of meter. The valve arms are connected to the flag rods, which gives practically a straight line pull of the valves, thus ensuring even working surfaces of the valve faces; consequently, there will be correct registration for a longer period.

Owing to there being no centre stuffing box, there is less possibility of binding; this also cuts out to a great extent the complaint of "leak in top." As the valve arms are connected to the flag rods, the diaphragms and valves have to work in perfect harmony; if it were not so, there would be erratic registration at various consumptions, and in consequence you would not be able to get the meter stamped; thus you are ensured that the meter is correctly designed.

Our Department has had 72 meters of this type made; they have now been on the district some nine months, and as far as I can tell, are giving perfect satisfaction.

The Open Top Meter.

The advantages claimed for the open top meter lie chiefly in the stuffing boxes, whose frictional resistance can be so reduced as to contribute materially to the relief of pressure absorption. In the closed top meter, the flag rod stuffing boxes have to be packed sufficiently tight to resist the full pressure of the gas. In the open top these same boxes only have differential pressure against them and so need very little packing—in fact, some firms use a cone and socket without packing. Again, the centre stuffing box is transferred to the index. This box, in some instances, only has a twentieth of the work to do as a centre stuffing box, so it is not so likely to leak. Furthermore, this type of meter dispenses with the long gas-way, which again helps to reduce the pressure loss.

When, however, it is all summed up and the meter tested against a modern closed top pattern, one will find that there is not more than one-tenth water pressure in it.

Our Department has tried a good number of these meters, but we are up against the trouble of condensation and deposits which settle on the working parts in the top of the meter, and, in many instances, this is so bad as to stop the meter from working. My explanation of this is that there is the complete area of the top of the meter for the gas to enter. The gas makes a bee-line for the valves; in consequence, part of the gas is not circulated and becomes stagnant. It is from this gas that we get the deposits that do so much damage. We have also found that the larger the meter the more trouble we get.

Transport of Meters.

In conclusion, I should like to say a few words about the transport of meters. Dry meters are vastly different from the cast-iron wet meters. The latter could receive a bump or two without making any material difference, but when you look at the tin plate and other parts which are used in the construction of a dry meter, it will be observed that a great deal of soldering has had to be done. Furthermore, a few of the parts are on the delicate side, such as valves, crank, and various guides. One must therefore come to the opinion that these types of meter need very careful handling from the time they leave the manufacturers until they are fixed in position on the district.

Discussion.

The PRESIDENT (Mr. J. H. Wainwright, Halesowen) said the author had devoted a lot of time to a description of the self-draining meter which had been designed in Birmingham. There was another way of getting over the difficulties of condensation, and that was to install a gas-drying plant at the works. They had 4½ years' experience with such a plant at Halesowen, and were very pleased with the help derived from it. He could quite definitely say that it was helpful in preserving the accuracy of registration of the meters. He noticed that the author had not stressed high-capacity meters to any extent, and he asked if

Mr. Knight thought they had come to stay and could be relied upon to the same extent as the standard meters. He asked if the author regarded the spraying of paraffin into meters as necessary or desirable. Referring to the question of dirty valves, some undertakings were unfortunately experiencing the presence of gum, and he wondered if this had a very bad effect on meter valves.

Mr. F. A. JENKINS (Leamington), in proposing a vote of thanks to Mr. Knight, asked to what extent wet meters were used now in Birmingham.

Mr. W. L. S. SPINKS (Birmingham), who seconded the vote, said he recognized probably more than those from other towns how much Mr. Knight was personally responsible for some of the improvements he had spoken of. If they compared a pre-war meter with one of the modern high-capacity there was a tremendous amount of "Knight" in the latter. Owing to the trouble experienced in Birmingham due to condensation, Mr. Knight designed and built the self-draining meter which had proved a great boon.

Mr. A. R. HAYDON (Dudley) referred to slot meter adjustments, which in his opinion were very complicated and kept up the cost of the meter.

Mr. W. H. SMIRLES (Birmingham), referring to the question of deposits in open top meters, said he was of the opinion that the fast moving gas passing from one part to another was the cause of the trouble. He wondered also whether drying the gas would not offer some explanation for the dry deposits which were sometimes found on the valve faces. He noted that the capacity of a dry meter was set by means of the tangent arms, and he presumed these were set according to a standard so that approximately every meter would be correct.

Author's Reply.

Mr. KNIGHT, in his reply, said that high-capacity meters had come to stay. In his opinion, the speed of meters did not matter so very much. In the old days everyone thought that if one had a dry meter which would do three revolutions instead of four, one was saving 25% of its life, but this, he thought, was a fallacy. In Birmingham they aimed at keeping a correct design and lay-out, and if this were done, and there was no strain on any part, then speed did not count. It was impossible to standardize meters, as the various engineers up and down the country insisted upon having different types. He did not believe in the spraying of meters with paraffin unless some part of the mechanism was sticking, as the leathers were treated with oil, and paraffin would not suit the dressing of every leather. Fortunately they had not experienced much trouble in Birmingham with gumming of valves, but when it did occur the valve stuck tight and something had to go. They had not bought any wet meters in Birmingham for some years, and there were now considerably more dry meters in use than wet.

On the point raised by Mr. Smirles regarding deposit in open top meters, he did not think it was the speed of the gas which caused this. The gas had access to the whole area of the top, which was in closer contact with the outside atmosphere than the ordinary closed top meter, and it made a direct line for the valves. In consequence, he thought that the gas in the near corners to the inlet was inclined to become stagnant, and it was from this gas that the deposit occurred.

The new self-draining meter did tend to seal the valves, although they did not depend upon it to do this.

Mid Southern Utility Company

Annual Meeting

The Annual Meeting of the Proprietors of the Mid Southern Utility Company was held at Farnborough on Thursday, Feb. 14, 1935—Mr. R. W. EDWARDS (Chairman of Directors) presiding.

The SECRETARY read the notice convening the Meeting, and after the minutes of the previous Annual General Meeting held on Feb. 15, 1934, had been confirmed, the CHAIRMAN rose to move the adoption of the Directors' Report and Accounts for the year 1934.

The Report was as follows:

The Directors present a statement of the Company's accounts for the year ended Dec. 31, 1934.

After providing for dividends on Consolidated Preference Stock, interest paid to Bank and on Redeemable Bonds and Debenture Stock, as well as for the statutory dividends paid for the half-year ended June 30, 1934, the Directors recommend the full statutory dividends of £6 4s.% per annum on the "A" Stock; £4 14s.% per annum on the "B" Stock; and £5% per annum on the "C" Stock for the latter half of the year, all less income-tax.

The business of the Company generally has been satisfactory.

Mr. Lionel Maltby, F.C.A. (of Messrs. Deloitte, Plender, Griffiths, & Co.) retires by rotation and is willing to serve again if re-elected.

Mr. C. P. Crookenden, F.C.A., is the retiring Director and, being eligible, offers himself for re-election.

R. W. EDWARDS,
Chairman.

Feb. 1, 1935.

The Chairman's Address

Addressing the Proprietors, the CHAIRMAN said: The Report and Accounts have now been in your possession for some days, and, with your permission, I propose to follow the usual course and take them as read.

Electricity.

This Department is developing satisfactorily. The total advance in sales (for Mid Southern Utility Company) as compared with the year 1933 (excluding consumptions on our various works—which fluctuate) represents 26·8%.

The following apparatus has been fixed during the past year:

Lamps	34,463
Motors	179
Fires	1,393
Cookers	305
Other cooking apparatus	186
Sweepers	106
Irons	549
Miscellaneous	346

representing an additional load of 6,466 KW. as compared with 3,720 KW. for the previous year.

As mentioned last year, it had been anticipated several years ago that with the prospective introduction of the "Grid" supplies it would be necessary to divorce our charges for non-domestic purposes other than lighting from those for domestic purposes, owing to the form in which the peak-load factor would be introduced into our calculations, and the alteration has been applied and accepted in almost every district, as from Christmas, 1931.

At the end of this year we must set about writing off the various generating plant displaced by the "Grid." The prospect of further development is good.

Gas.

The sales of gas for the past year show an increase of 1·33%.

The climatic conditions closely approximated to those of the previous year, the net average of mean night temperatures being 42·175°, as against 41·916°, although the month of December proved an outstanding exception, the average day temperature being 50·5°, as compared with 37·8° last year, and the mean night temperature 43·3° compared with 29·9°.

The following apparatus was added during the year:

Cookers	2,012
Fires	377
Water heaters	1,304

Where gas is available we still find the average housewife strong in her allegiance to it as a cooking medium, and there are so many processes, apart from the household, wherein the primary considerations are dependability and an infinitely variable temperature control, that I have no fear of such a flexible fuel being ousted from public favour.

The amount received from residuals was again disappointing, representing 45·4% of the cost of coal as compared with 46·72% in the previous year. The revenue from coke shows some improvement, but this is unfortunately overcome by the further decline in tar, while ammonia products continue to be a flat and unprofitable market. The yield in liquid products (calculated on ammoniacal liquor of 8 oz. strength) was 44·10 gallons per ton of coal carbonized, as compared with 48·01 gallons for the previous year.

Water.

This Department has been satisfactory, and the various plants, reservoirs, and underground works have been well maintained.

The total rainfall as recorded by us for the year was 24·02 in. (6·49 in. falling in December) as compared with 26·685 in. for 1933.

The average net domestic consumption per head per day was 12·61 gallons, which, having regard to all the circumstances, again reflects the greatest credit on our consumers in their prudent use of water during very dry weather, as well as on the property owners, who attend to the maintenance of the fittings, and on our Inspectors, who are assiduous in their duties.

Capital.

For the three undertakings, the amount of capital authorized is £1,836,367 14s. 2d. Of this there has been received £1,537,905 9s. 7d. Deducting the credit balance of £88,331 11s. 1d. we arrive at the total of £1,449,573 18s. 6d., and allow-

ing for the amount added on consolidation, there is a net expenditure of £1,408,584 10s. 3d.

Over the past year, after deducting depreciation of £21,097 17s. 11d., the capital expended was £89,694 11s. 4d.

General.

During the year we added 7,385 consumers in all departments (including subsidiary undertakings), making a net increase of 31,372 in eleven years.

A very substantial increase has taken place in our rating assessments under the recent re-valuations, and we have reluctantly to admit the adverse effect on the economical working of our Companies. As an illustration, it may be sufficient to say that in the Electricity Department of the parent Company alone the assessment is increased by £8,000, and the expenditure on rates represents nearly 12% (11·8) of the total expenditure in that Department. The subsidiary undertakings are even more severely affected in proportion, in one case the assessment being multiplied more than five times.

The various Welfare Schemes continue to flourish. For the year ended June 30, 1934, the Co-partnership bonus was 7·7%, as in the previous year, and the excellent facilities provided for sports have been used to good advantage.. The ever-increasing body of employees over a very wide area benefits from the unobtrusive, but no less effective, work of the Hospital and Benevolent Fund, and the ministrations of the various hospitals and other organizations with which it is associated. The Directors recognize and appreciate the devoted service of all employees, and the efficient work and oversight of the various officials and principal officers.

Generally, the outlook is good, and the next few years should very substantially increase and broaden the trading returns of the Company.

In conclusion, I now move the following resolution, which I will ask the Deputy-Chairman, Mr. T. A. Braddock, to second:

> "That the Directors' Report and Statement of Accounts for the twelve months ended Dec. 31, 1934, be and are hereby adopted, and that the dividends as therein recommended be and are hereby declared to be payable to the Proprietors on March 1."

This was unanimously adopted, and, after Mr. C. P. Crookenden had been re-elected a Director and Mr. Lionel Maltby, F.C.A., as Auditor of the Company, the customary vote of thanks to the Chairman, Directors, and Staff concluded the ordinary business.

Extraordinary Meeting.

The CHAIRMAN then introduced the Extraordinary Meeting by calling upon the Secretary to read the notice, after which he moved the following resolutions:

(1) That the application of the Company to the Electricity Commissioners for a Special Order under the Electricity (Supply) Acts, 1882 to 1933, for the following purposes—namely,

(i) To extend the electrical limits of supply of the Company by the inclusion therein of the Parishes of Bradley, Mapledurwell and Up Nately Nutley Popham Preston Candover and Woodmancott in the Rural District of Basingstoke so much of the Parish of Hook in the Rural District of Hartley Wintney as prior to the coming into operation of the County of Southampton Review Order, 1932, formed part of the Parish of Up Nately in the Rural District of Basingstoke and so much of the Parishes of Laverstoke and Overton in the Rural District of Kingsclere and Whitchurch as prior to the coming into operation of the County of Southampton Review Order, 1932, formed the parish of Freefolk Manor in the Rural District of Whitchurch and part of the Parish of Popham in the Rural District of Basingstoke respectively:

(ii) To increase the Capital and Borrowing Powers of the Company for the purposes of the said Special Order and for the general purposes of the Company

be and is hereby approved.

(2) That when and so soon as the said Special Order has been made confirmed and approved the Directors be and they are hereby authorized to raise all or any part of the additional Capital which may be authorized by the said Special Order by the creation and issue of "B" Consolidated Stock or "C" Consolidated Stock or Consolidated Preference Stock or wholly or partially by one or more of those modes respectively.

(3) That the raising of capital so authorized may be made by the Directors at such times in such amounts on such terms and subject to such conditions as they shall from time to time determine and any Stock issued as Preference Stock may be issued so as to be Redeemable or Irredeemable.

(4) That the Directors be and they are hereby authorized to raise at such times in such amounts on such terms and subject to such conditions and at such rate or rates of Interest as they may from time to time determine all moneys which the Company may from time to time be authorized to borrow under the provisions of the said Special Order or under the Gas Undertakings Act, 1929, or any statutory modification thereof in respect of the Capital authorized by the said Special Order and that all such moneys may be raised on Mortgage or by the issue of Debenture Stock and any Debenture Stock may be issued so as to be Redeemable or Irredeemable.

These were formally seconded by the DEPUTY-CHAIRMAN and unanimously adopted.

Gas Undertakings' Results for 1934

Altrincham.

The report and accounts of the Directors of the Altrincham Gas Company for the year 1934 state that the profit shown by the revenue account is £16,508. The balance shown by the profit and loss account as available for dividend is £8,289, which will provide for payment of the full statutory dividends, less income-tax, and leave a balance of £4,047 to be carried forward. The quantity of gas sold during the year was 488,546,100 c.ft., being an increase over the previous year of 31,539,200 c.ft., or 6·9%. The Directors record with deep regret the loss of their valued and much esteemed Chairman, Mr. W. W. Baker, who died during the year. He was a member of the Board for the long period of 26 years, ably filling the office of Chairman for 9 years. Mr. Arthur Percy Hill was appointed to fill the vacancy on the Board caused by his death. The Directors also deeply regret to announce the death of their respected Engineer and Manager, Mr. H. R. S. Williams, and desire to place on record their high appreciation of his long and faithful service with the Company.

Bath.

The annual report and statement of accounts of the Directors of the Bath Gas Company to Dec. 31, 1934, state that mains were extended to supply Marshfield, Biddestone, and Upper Swainswick. Notwithstanding the exceptionally mild winter, there was an increased demand for gas for all purposes, and the sales during the past year constituted a record in the history of the Company. Subject to the approval of the shareholders, an agreement has been entered into for the purchase of the Melksham Gaslight and Coke Company, Ltd. If approved, application will be made to the Board of Trade during this year to enable this agreement to be carried out, and also for additional general powers. A dividend of 2½%, less income-tax, was paid in August last for the half-year to June 30, 1934, and the Directors recommend that under the powers obtained in the Bath Gas Order, 1932, a dividend of 3%, less income-tax, be declared for the half-year ended Dec. 31, 1934, payable on Feb. 28 next, making a total of 5½%, less income-tax, for the year. The Directors propose to put in force a scheme enabling the employees of the Company to participate in the profits of the Undertaking as part of the terms of remuneration for their services.

Bristol.

There has been a slight decrease in the sale of gas by the Bristol Gas Company, owing to the abnormally mild weather which prevailed throughout the autumn. The number of consumers is now 116,700, an increase of 3,895 as compared with 1933, while the number of cookers supplied by the Company has increased to 103,236. The sale of domestic and industrial gas appliances during the year constitutes a record in the history of the Company. The reconstruction of the offices and showrooms at Colston Street is now nearing completion, and it is anticipated that the new showrooms will rank among the most up-to-date in the country, and that the building will provide much better facilities for the carrying on of the Company's business under present-day conditions. The Directors recommend that a dividend be declared for the half-year ended Dec. 31, 1934, at the rate of 5% per annum, subject to the deduction of income-tax, on the nominal capital of the Company entitled to dividend.

Cheltenham.

The Directors of the Cheltenham Gas Company submit accounts for the year ended Dec. 31, 1934, showing a profit of £21,221. The Directors propose to allocate the sum of £2,000 to the retort renewals account, carrying forward in the profit and loss account the sum of £14,543 subject to the half-year's dividend to Dec. 31, 1934. The quantity of gas sold to consumers during the year was 628,925,900 c.ft., showing an increase of over 9,000,000 c.ft., mainly attributable to additional consumers in the Pershore and Broadway areas. As the result of offers to purchase the Company's consolidated ordinary stock for cash, or in exchange for its shares, the Severn Valley Gas Corporation, Ltd., has acquired a majority holding, and appropriate representation on the Company's Board of Directors was arranged. The Company has now been brought into co-opera-

tion with neighbouring gas companies likewise controlled by the Severn Valley Gas Corporation, and the advantages of these developments are already beginning to operate. The Directors recommend the payment of a dividend at the rate of 5% per annum on the paid-up consolidated ordinary stock.

Croydon.

The Directors' report and statement of accounts for the Croydon Gas Company to Dec. 31, 1934, state that the sale of gas during the past year shows an increase over that of the previous year, and the number of consumers has increased by 4,827. On the quinquennial assessment of the Undertaking the Directors have to report that a very substantial increase has been made in the valuation of local rates. The accounts show that after deducting dividends for the half-year ended June 30, 1934 (at the rate per annum of 7½% on the redeemable preference stock, 5% on the maximum dividend stock, and 7% on the sliding-scale stock), providing for all fixed charges, transferring £1,009 to the reserve fund, and appropriating £10,000 to the pension fund and £7,500 to the renewal fund, there remains for division, including the sum of £46,560 brought forward from 1933, a balance of £95,105, and the Directors recommend that dividends be declared for the half-year to Dec. 31, 1934, at the following rates % per annum, less income-tax—viz., redeemable preference stock 7½, maximum dividend stock 5, and sliding-scale stock 7. This will absorb the sum of £47,004, leaving a balance of £48,101 to be carried forward to the next account.

East Surrey.

Despite the abnormally mild weather prevailing during December, the sale of gas for the year by the East Surrey Gas Company shows the satisfactory increase of 4·39%. The Directors issued by tender during the year £25,000 4½% redeemable preference stock, at an average price of £112 8s. 8d.%. Dividends at the under-mentioned rates per annum respectively—6% on the cumulative preference stock, 4½% on the redeemable preference stock, 5¼% on the preference "A" stock, and 6% on the ordinary "B" stock, all less income-tax—were paid for the half-year to June 30. The Directors recommend that similar dividends be paid in respect of such capital for the second half-year (less income-tax) payable on March 1 next, leaving a balance of £5,478 18s. 6d. to be carried forward.

Grantham.

The annual report of the Directors of the Grantham Gas Company shows a balance standing to the credit of the profit and loss account after the payment of the interim dividend last August of £7,394. The Directors recommended the payment of a final dividend of 3½%, less income-tax, making the total dividend for the year 6%, less tax. For some time past it has been customary to pay a dividend of 5%.

Littleborough.

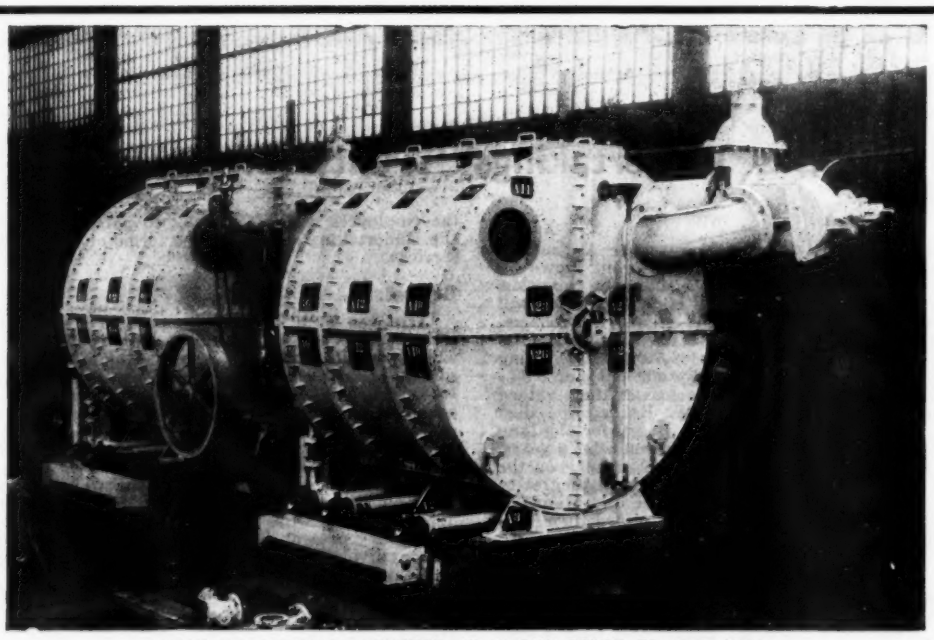
The accounts of the Littleborough Gas Company showed that the receipts from the sale of gas for the six months ended Dec. 31, 1934, were £7,805, compared with £8,146 for the corresponding period of 1933. The revenue profit was £1,274, against £1,140, and the balance available for dividend was £1,273, compared with £1,377. A dividend at the rate of 10% per annum, less income-tax, was sanctioned.

Maidstone (S.E. Gas Corporation).

The report and statement of accounts of the Maidstone Gas Company for the year ended Dec. 31, 1934, state that, after paying in respect of the half-year a dividend at the rate of £8% per annum on the 5% capital stock, and after providing for all fixed charges (including £2,000 for depreciation of meters and a contribution to the reserve fund of £2,505) there is a total available balance of £10,255, out of which the Directors recommend the payment of a dividend at the rate of £10% per annum on the 5% capital stock, which will absorb the sum of £6,422, leaving £3,832 to be carried forward to the credit of the current year. The sum of £11,320 has been written off the commuted pensions suspense account. Owing to the mild weather prevailing during the latter part of the year, the sales of gas show a slight decrease compared with the year 1933.

Portsmouth.

The statement of accounts and report of the Directors of the Portsmouth Gas Company for the year ended Dec. 31, 1934, state that the Directors recommend a dividend of 5% on the 5% maximum stock, and of 8¼% on the consolidated stock, both less income-tax, be declared for the year, and that such dividend, after deduction of the interim payment made on Sept. 1 last, be paid on March 1. The amount carried forward after payment of the total dividend was £47,312. The exceptionally mild weather which prevailed during November and December was the means of severely checking the consumption of gas, and of preventing what would otherwise have been an increased output. Progress in the Company's business during the year has been very gratifying, the number of consumers showing a satisfactory increase, whilst the number of cooking and heating appliances supplied was a record in the history of the Company. The new gasholder at Emsworth was completed during the year,



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and was put into operation on July 31. Land has recently been purchased in the Horndean area for the proposed erection of a distributing and storage works in that district, and application has been made to the Board of Trade for permission to use such land for that purpose. A Special Order was granted by the Board of Trade on Nov. 16 last, empowering the Company to reduce the price of gas in Waterlooville, Havant, Emsworth, and other outlying districts, at an earlier date than has hitherto been permissible under the provisions of the Board of Trade Orders of 1926 and 1927.

Sheffield.

The report of the Directors of the Sheffield Gas Company for the year ended Dec. 31, 1934, states that the total quantity of gas sold during the past year was 5,966,549,000 c.ft., being an increase of 642,569,000 c.ft., or 12·07% on the previous year. The price of gas throughout the year has remained at 6⁸d. per therm, or 2s. 9d. per 1,000 c.ft., for small quantities, with proportionate reductions to large consumers, the lowest prices being 2⅔d. per therm, or 1s. per 1,000 c.ft., and 2d. per therm, or 10d. per 1,000 c.ft., for special large quantities. An interim dividend at the rate of 6% per annum was paid for the half-year ended June 30, 1934, and it is now proposed to pay a final dividend to Dec. 31, 1934, at the same rate, making a total distribution for the year of 6%. After the payment of these dividends there remains a balance of £64,183 to be carried forward.

Tottenham.

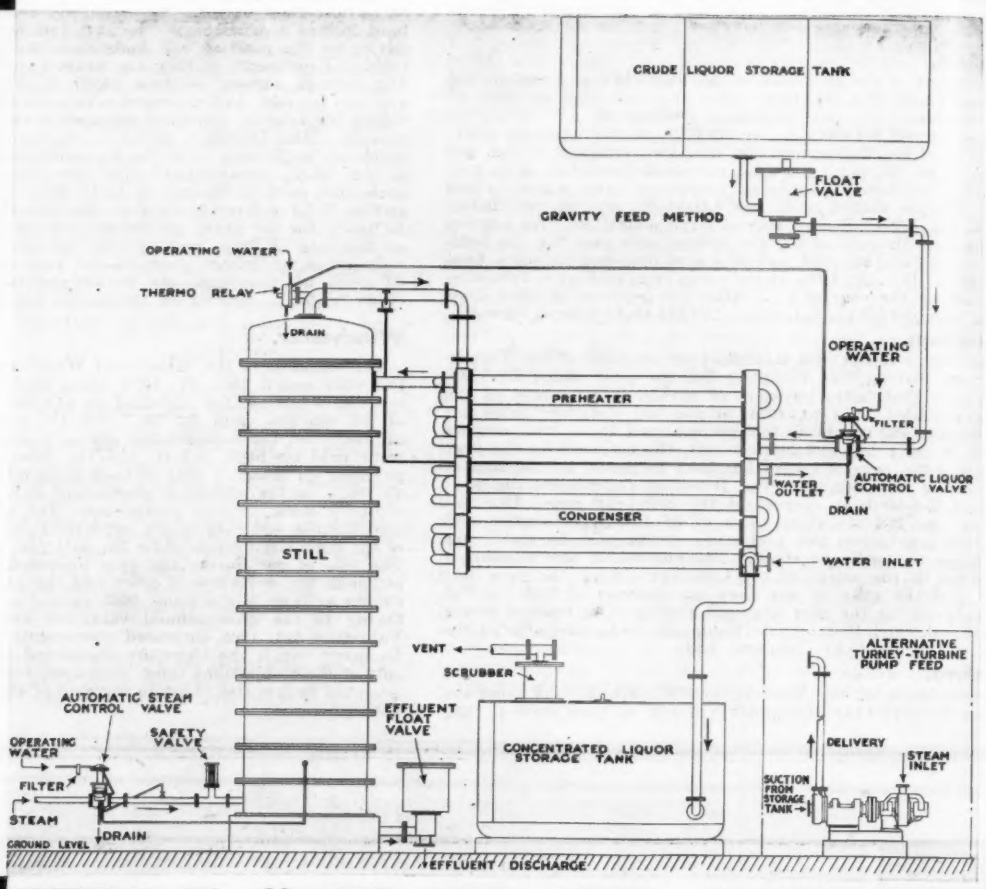
The annual report and statement of accounts of the Tottenham and District Gas Company for the year ended Dec. 31, 1934, show that, after payment of dividends in respect of the half-year ended June 30, 1934, at the full statutory rates, all less income-tax, providing for interest, and the special charges set out in the profit and loss account, the accounts for the year show that the carry forward has been increased by the sum of £92, and is now £52,850. The Directors recommend the payment of dividends in respect of the half-year ended Dec. 31, 1934, at the full statutory rates of £5 10s.% per annum and £5% per annum on the preference stocks and £6 15s.% per annum on the ordinary stock. The number of new consumers connected to the mains of the Company during the year was 4,465, and the sales of gas show an increase of 3·35%. The Company during the year acquired a controlling interest in the Biggleswade and District Gas Company, Ltd., and also in the Shefford Gas and Coke Company, Ltd.

Watford.

The accounts of the Watford and St. Albans Gas Company include figures for the Rickmansworth area as from April 1, 1934, the date on which the Rickmansworth Undertaking was taken over by the Company. The gas sold during the year amounted to 1,477,752,800 c.ft., representing an increase of 5·7% over the corresponding 1933 sales, while the gas apparatus sold by the Company shows that 1934 has been a record year. The continued demand for gas for all purposes makes it necessary for the Directors to increase the works and mains of the Company. Debenture and preference stocks were raised during the year on advantageous terms. An actuarial valuation of the pension fund showed a deficiency. The Directors have, therefore, taken advice on the position and have made such alterations to the rules and payments as they are advised will stabilize the fund. The revenue account shows a profit of £74,552, and the profit and loss account (net revenue) a balance of £51,349, after providing for interim dividends and debenture interest and other charges. The Directors therefore recommend the payment of dividends as follows: On the 5% preference stock at the rate of £2 10s.%, making £5% for the year; on the new 5% preference stock at the rate of £2 1s. 8d.% (5 months' dividend); on the 5½% preference stock at the rate of £2 15s.%, making £5 10s.% for the year; on the 6% redeemable preference stock at the rate of £3%, making £6% for the year; on the 7½% redeemable preference stock at the rate of £3 15s.%, making £7 10s.% for the year; and on the ordinary stock at the rate of £3 7s. 6d.%, making £6 15s.%—all less income-tax.

Winchester.

The accounts of the Winchester Water and Gas Company for the year ended Dec. 31, 1934, state that the balance of net revenue available for dividend is £14,293. Interim dividends of £2, £2 15s., and £2 10s.% on the preference stocks and £2 10s.% on the consolidated ordinary stock, less income-tax, were paid on Sept. 1 last, and the Directors recommend the payment on March 1 next of final dividends of £2, £2 15s., and £2 10s.% on the preference stocks and £3% on the consolidated ordinary stock, all less income-tax. The additional ½% on the consolidated ordinary stock represents the undivided portion of the authorized dividend for the half-year ended June 30, 1907. The sale of gas during the year exceeded the record of 1933, although the reduction in price and the granting of larger discounts as from Michaelmas, 1933, caused a decrease in revenue. Owing to the quinquennial valuation under the Rating and Valuation Act, 1925, increased assessments were made upon the Company which the Directors considered oppressive. As a result of their objections these assessments were reduced, but the accepted figures still show an increase of 45% on the Gas Undertaking.



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Gas Markets and Manufactures

Stock Market Report

(For Stock and Share List, see later page)

For the first half of last week markets suffered from an attack of nerves which led to a widespread selling movement with a consequent substantial marking down of prices, the reaction being most noticeable in the gilt-edged and investment sections. Several factors were responsible for the uneasiness, notably the liquidation brought about by the crisis in Mincing Lane and the political situation over the Italy-Abyssinia affair. During the latter part of the week, however, confidence began to return, especially after the Chancellor of the Exchequer's optimistic speech in the House of Commons; prices recovered some of their previous losses, and the Account closed on Friday with the prospect of brighter conditions during the current week.

In contrast to the general situation, the Gas Market maintained a firm front throughout, though prices on the whole showed little change. It will be seen in the Stock and Share List that a few stocks advanced a point or two, while the only small reactions of note were in Gas Light units which eased 3d. to 28s., and South Metropolitan ordinary with a drop of 2 to 137½, both *ex* div.

Further dividend announcements appeared during the week, and it is satisfactory to note that not only have the rates been maintained in each case, but, despite the abnormal climatic conditions of last year, the majority of companies also report increased sales of gas and profits. Among these are the following:

—	Dividends, 1934.		
	1st Half-Year.	2nd Half-Year.	Full Year.
	%	%	%
Barnet	3½	3½	7
Croydon sliding-scale	3½	3½	7
Derby	3½	5	8½
Maidstone	4	5	9
Sheffield	3	3	6
Southampton	2½	2½	5
Winchester Water and Gas	2½	3*	5½

* The additional ½% represents the undivided portion of the authorized dividend for the half-year ended June 30, 1907.

Current Sales of Gas Products

The London Market for Tar Products.

LONDON, *Feb.* 18.

The prices of tar products generally remain unchanged, there being but few changes to report.

Pitch is about 45s. per ton f.o.b.

Creosote, 5d. to 5¼d.

Refined tar, 4d. per gallon in bulk at makers' works.

Pure toluole, 2s. 2d. to 2s. 3d.; pure benzole, 1s. 9d. to 1s. 10d.; 95/160 solvent naphtha, 1s. 5d.; and 90/160 pyridine, about 5s. 9d.—all per gallon at makers' works.

Tar Products in the Provinces.

Feb. 18.

The average prices of gas-works products during the week were: Gas-works tar, 20s. 6d. to 25s. 6d. Pitch—East Coast, 41s. 3d. to 43s. 9d. f.o.b. West Coast—Manchester, Liverpool, Clyde, 41s. 3d. to 43s. 9d.* Toluole, naked, North, 1s. 7d. to 1s. 9d. Coal-tar crude naphtha, in bulk, North, 6½d. to 6¾d. Solvent naphtha, naked, North, 1s. 4½d. to 1s. 4¾d. Heavy naphtha, North, 9¾d. to 10¾d. Creosote, *ex* works, in bulk, North, liquid and salty, 4⅝d. to 4½d.; low gravity, 4⅜d. to 4½d.; Scotland, 4⅝d. to 4½d. Heavy oils, in bulk, North, 4d. to 4¼d. Carbolic acid, 60's, 1s. 10d. to 1s. 11d. Naphthalene, £10 to £11. Salts, 55s. to 75s., bags included. Anthracene "A" quality, 2½d. to 3d. per minimum 40%, purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Feb.* 16.

Creosote oil is quite active with prompt supplies on the short side, but other products command little attention at present.

Crude gas-works tar.—Actual value remains at 29s. to 31s. per ton *ex* works in bulk.

Pitch.—There is more shipping activity, but new business is difficult and prices are nominal at 43s. to 44s. per ton f.o.b. Glasgow for export and 42s. 6d. per ton *ex* works in bulk for home trade.

Refined tar.—Competition is keen, but works are holding for 3d. to 3¼d. per gallon f.o.r. naked.

Creosote oil is rather difficult with prompt supplies scarce. To-day's values are not lower than the following: B.E.S.A. Specification, 4¾d. to 5d. per gallon; low gravity, 4¾d. to 5d. per gallon; and neutral oil, 4⅝d. to 4⅞d. per gallon; all f.o.r. in bulk.

Cresylic acid.—At the moment there is a lack of interest, but values are maintained. Pale, 97/99%, 1s. 3d. to 1s. 4d. per gallon; dark, 97/99%, 1s. 1d. to 1s. 2d. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 5d. per gallon; all *ex* works.

Crude naphtha is only available in small quantities at 4d. to 4½d. per gallon, according to quality and district.

Solvent naphtha.—90/160 grade is 1s. 3d. to 1s. 4d. per gallon, and 90/190 heavy is 9d. to 10d. per gallon.

Motor benzole is available in small but regular quantities at 1s. 3d. to 1s. 4d. per gallon *ex* works in bulk.

Pyridines.—90/160 grade is 5s. 6d. to 6s. per gallon, and 90/140 grade 6s. to 6s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole	0 9	to	0 9½	per gallon at works
Motor ,,	1 3½	,,	1 4	,, ,, ,,
90% ,,	1 4	,,	1 4½	,, ,, ,,
Pure ,,	1 7½	,,	1 8	,, ,, ,,

Contracts Advertised To-Day

Coal.

Penrith U.D.C. [p. 468.]
Skipton Gas Department. [p. 468.]

Condenser, &c.

Dawlish Gas and Coke Company, Ltd. [p. 468.]

Lighting Goods (Mantles, Fittings, &c.).

Spenborough Gas Department. [p. 468.]

Meters, &c.

Birmingham Gas Department. [p. 468.]
Spenborough Gas Department. [p. 468.]
Manchester Gas Department. [p. 468.]

Oxide of Iron (New and Spent).

Manchester Gas Department. [p. 468.]

Pipes, &c.

Spenborough Gas Department. [p. 468.]

Retorts, &c.

Skipton Gas Department. [p. 468.]

Stores (Iron, Bolts and Nuts, &c.).

Spenborough Gas Department. [p. 468.]

Washer and Scrubber.

Dawlish Gas and Coke Company, Ltd. [p. 468.]

Overseas Opportunities

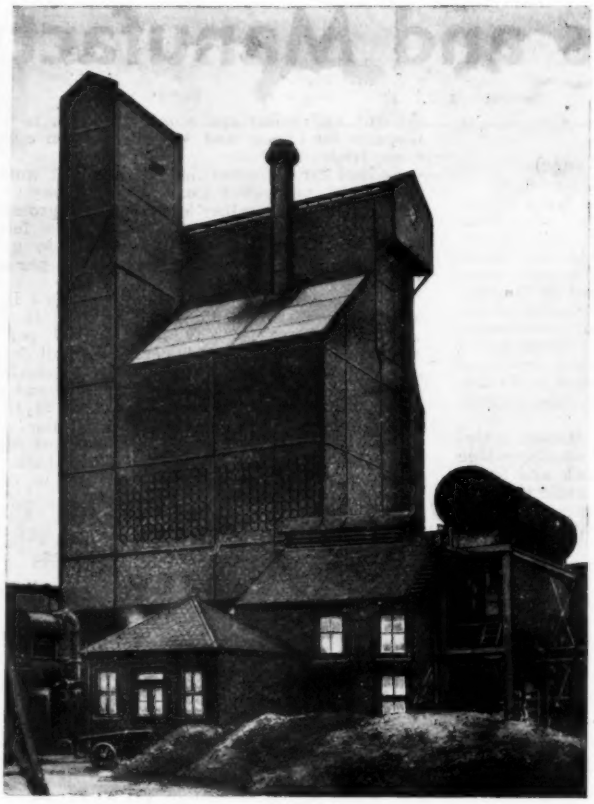
Cairo.

The Commercial Secretary to the Residency, Egypt, reports that the Ministry of Public Works is calling for tenders, to be presented in Cairo by March 2, 1935, for the supply and fixing of steam boilers, hot-water calorifiers, cooking apparatus, vegetable boilers, milk pans, and stainless steel sinks. (Ref. G.Y. 14787.)

The Hague.

H.M. Commercial Secretary at The Hague has forwarded notification of the following projected extension of the Bloemsingel Gas-Works. The Management of the Municipal Gas-Works, Bloemsingel, Groningen, is preparing plans with the co-operation of the Department of Municipal Works for an important extension of the Municipal Gas-Works, consisting of a new pressure installation, regulating and measuring station, the laying down of pressure pipe lines, and an extension of the machine rooms. The work is estimated to cost 215,000 fl., and is expected to be put in hand in the course of the next two months.

It should be noted that the above is advance information only and that no further details are available at the Department of Overseas Trade. It is suggested that British firms interested should consult their Dutch agents concerning any further information they may require. (Ref. D.O.T. 32575/1934.)



LEVEN, SCOTLAND

This installation of 12 Glover-West vertical retorts with a nominal total daily capacity of 720,000 cubic feet was built at the works of the Buckhaven and Leven Gas Commissioners in 1926. An order was recently received from the Commissioners for a second installation, on which work is now proceeding. This unit will comprise a further four retorts, bringing up the nominal daily capacity of the plant to 960,000 cubic feet.

Another repeat order for

GLOVER-WEST VERTICAL RETORTS

IN Scotland there are now 27 gasworks equipped with Glover-West vertical retorts. At twelve of these works extensions have been or are being added. The Montrose Gas Company, Ltd., the Falkirk Corporation Gas Department and the Johnstone Corporation Gas Department are amongst the undertakings from whom repeat orders have recently been received.

Considerably more than 510 million cubic feet is the estimated total daily gas output of Glover-West vertical retort plant in the United Kingdom and in 20 countries overseas. The total number of retorts installed exceeds 10,000. Out of more than 230 of the world's gas undertakings now equipped with Glover-West vertical retorts, repeat orders for extensions have been received from no less than 150.

This Company continues to pursue a policy of constant effort towards the further advancement of modern gasworks practice. We are prepared at all times to co-operate with engineers and administrators to the full extent of the resources of our organization, in the common interest of gas progress.

GLOVER-WEST VERTICAL RETORTS . . . WESTVERTICAL CARBONIZING CHAMBERS . . . THE WEST LIP-BUCKET CONVEYOR WITH AUTOMATIC FORCED LUBRICATION . . . BELT AND PUSHPLATE CONVEYORS . . . ELEVATORS . . COAL BREAKERS . . . COKE CUTTERS . . . WAGON TIPPLERS . . . SKIP HOISTS . . . TELPHER PLANT WASTE-HEAT RECOVERY AND BREEZE-BURNING EQUIPMENT

WEST'S CARBONIZING & FUEL-HANDLING SYSTEMS

WEST'S GAS IMPROVEMENT COMPANY, LTD.

LONDON - REGENT HOUSE, KINGSWAY, W.C.2 'Phone: HOLBORN 4108. 'Grams: "IMVERTRET, WESTCENT" MANCHESTER - ALBION IRONWORKS, MILES PLATTING 'Phone: COLLYHURST 2961. 'Grams: "STOKER, MANCHESTER

STOCK AND SHARE LIST

Official Quotations on the London and Provincial Stock Exchanges

Issue. £	Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations, Feb. 15.	Rise or Fall on Week.	Transactions; Lowest and Highest Prices During the Week.
1,551,868	Stk.	Sept. 10	7	7	Alliance & Dublin Ord. ...	135—145	...	...
374,000	,,	Dec. 17	4	4	Do. 4 p.c. Deb. ...	90—100	...	100¾
557,655	,,	Aug. 13	7	7	Barnet Ord. 7 p.c.	170—175	+2	173½—175
300,000	1	Oct. 8	1,9⅛	1/4⅛	Bombay, Ltd.	30 —32/-	...	31/—31/3
178,480	Stk.	Aug. 13	9½	9½	Bournemouth sliding scale ...	227—237	...	...
550,050	,,	,,	7	7	Do. 7 p.c. max. ...	172—177	...	...
439,160	,,	,,	6	6	Do. 6 p.c. Pref. ...	150—155	...	...
50,000	,,	Dec. 17	3	3	Do. 3 p.c. Deb. ...	86—91	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	107—112	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	130—135	...	...
357,900	,,	Aug. 13	7½	7½	Brighton, &c., 6 p.c. Con. ...	181—186	...	...
540,000	,,	,,	6¾	6¾	Do. 5 p.c. Con. ...	162—167	+2	164
195,500	,,	,,	6	6	Do. 6 p.c. B. Pref.	145—150	...	...
1,487,500	,,	Feb. 4	5	5	Bristol, 5 p.c. max.	120—122*a*	...	...
120,420	,,	Dec. 17	4	4	Do. 1st 4 p.c. Deb. ...	102—104*a*	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	102—104*a*	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	122—124*a*	...	...
855,000	,,	Sept. 24	8	7	British Ord.	174—179	...	176
100,000	,,	Dec. 17	7	7	Do. 7 p.c. Pref.	160—165	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	97—102	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	111—116	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1—3	...	...
100,000	10	6 Nov. '33	4½	4½	Do. 4½ p.c. Pref. ...	1—3	...	...
150,000	Stk.	Dec. 17	4½	4½	Do. 4½ p.c. Deb. ...	88—93	−2	89—90¾
626,860	,,	Jan. 21	6	6	Cardiff Con. Ord.	133—138	...	...
237,860	,,	Dec. 17	5	5	Do. 5 p.c. Red. Deb.	105—110	...	...
157,150	,,	Feb. 4	5	6½	Chester 5 p.c. Ord.	111—116*b**	...	...
98,936	1	Sept. 24	2/-	2/-	Colombo, Ltd., Ord.	1⅞—1⅞	...	36/—36/6
24,500	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. ...	19/6—21/6	...	20/6
609,204	1	Sept. 24	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	20/—22/-	+-/6	21/4½—22/-
296,053	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	25/—27/-	...	...
1,775,005	Stk.	Feb. 4	5	6	Commercial Ord.	120—125*	...	120—123
475,000	,,	Dec. 3	3	3	Do. 3 p.c. Deb. ...	88—92	...	...
286,344	,,	Aug. 13	5	5	Do. 5 p.c. Deb. ...	125—130	...	129—132
807,560	,,	Aug. 13	7	7	Croydon sliding scale... ...	167—172	...	169
569,590	,,	,,	5	5	Do. max. div. ...	116—121	...	118—119
620,385	,,	Dec. 17	5	5	Do. 5 p.c. Deb.	130—135	...	132½
542,270	,,	Aug. 13	10	7	Derby Con.	200—210*c*	...	...
55,000	,,	Dec. 17	4	4	Do. 4 p.c. Deb.	100—105*c*	...	...
239,000	,,	Feb. 4	5	5	East Hull Ord. 5 p.c. ...	111—116*	...	...
181,625	,,	Feb. 4	6	6	East Surrey Ord 5 p.c.	138—143*	...	143½
175,609	,,	Dec. 17	5	5	Do. 5 p.c. Deb. ...	123—128	...	...
1,002,180	,,	Sept. 10	†7	†5	European, Ltd.	120—125	...	121½
19,313,481	,,	Feb. 4	5⅞	5⅞	Gas Light & Coke 4 p.c. Ord.	27/6—28/6*f**	−-/3	27/7½—28/4½
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	93—97*	...	96—97
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	109—112*	...	110½—112½
6,102,497	,,	Dec. 3	3	3	Do. 3 p.c. Con. Deb. ...	92—95	...	92—94
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	118—121	−1	118½—121
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	117—120	...	118½—119½
270,466	,,	Aug. 13	6	6	Harrogate New Cons. ...	140—145	...	...
140,000	1	Sept. 24	1/7½	1/7½	Hongkong & China, Ltd. ...	1⅝—1⅝	...	...
213,200	Stk.	Aug. 13	6	6	Hornsey Con. 3½ p.c....	137—142	...	...
5,600,000	,,	Oct. 22	14	10	Imperial Continental Cap. ...	217—222	...	218—221
223,130	,,	Jan. 21	3½	3½	Do. 3½ p.c. Red. Debs.	91—96*	...	...
285,242	,,	Aug. 13	8½	8½	Lea Bridge 5 p.c. Ord. ...	190—200	...	...
2,167,410	,,	Aug. 13	6	6	Liverpool 5 p.c. Ord.... ...	145—147*b*	...	...
245,500	,,	Dec. 17	5	5	Do. 5 p.c. Red. Pref. ...	105—110*b*	...	...
306,083	,,	Jan. 16	4	4	Do. 4 p.c. Deb.	104—107*b*	...	...
11,751	,,	Aug. 27	10	8	Maidstone 5 p.c. Cap. ...	188—198	...	...
63,480	,,	Dec. 17	3	3	Do. 3 p.c. Deb. ...	83—88	...	...
75,000	,,	Dec. 3	†10	†10	Malta & Mediterranean ...	205—215	...	...
392,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	102—107	...	...
231,978	Stk.	Feb. 4	5	5	M. S. Utility "C" Cons. ...	113—118*	...	...
818,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	101—106*	+1	104
360,075	,,	Dec. 17	4	4	Do. 4 p.c. Deb. ...	102—107	...	...
148,955	,,	,,	5	†5	Do. 5 p.c. Deb. ...	127—132	...	...
125,000	—	Jan. 2	11/8	3½	Do. 3½ p.c. Rd. Rg. Bds.	98—101	...	...
675,000	,,	May 28	†6	††3	Montevideo, Ltd.	55—65	...	55
2,061,315	,,	Aug. 13	5¼	5	Newcastle & Gateshead Con.	26/6—27/6*df*	...	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	107—109*d*	...	...
776,706	,,	Dec. 17	3½	3½	Do. 3½ p.c. Deb. ...	100—102*d*	...	...
277,285	,,	Oct 8	5	5	Do. 5 p.c. Deb. '43 ...	105—107*d*	...	...
274,000	,,	Feb. 4	5	5	Newport (Mon.) 5 p.c. max....	108—110*a**	...	...
204,940	,,	Aug. 13	7½	7½	North Middlesex 6 p.c. Con.	172—177	...	175
396,160	,,	Feb. 4	5	5	Northampton 5 p.c. max. ...	105—110*	...	...
300,000	,,	Nov. 5	†7	†9	Oriental, Ltd.	170—175	...	174½
416,617	,,	Dec. 17	8	8	Plym'th & Stonehouse 5 p.c.	182—187	...	184½—186½
504,416	,,	Feb. 4	8	8½	Portsm'th Con. Stk. 4 p.c. Std.	182—187*	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	110—115*	...	...
114,000	,,	Jan. 21	5	5	Preston 5 p.c. Pref.	108—113	...	...
1,736,968	Stk.	Aug. 27	6	6	Sheffield Cons.	148—150*e*	+1	...
95,000	,,	Jan. 7	4	4	Do. 4 p.c. Deb.	100—104*e*	...	...
133,201	,,	Aug. 13	5	8½	Shrewsbury 5 p.c. Ord. ...	155—160	...	...
90,000	10	May 28	‡4	‡3	South African	3—4	...	3½
927,177	1	Sept. 10	1/2⅜	1/2⅜	South East'n Gas Cn. Ld. Ord.	29/—31/-	...	29/9
736,061	1	,,	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pref.	22/6—23/6	...	22/9—22/10½
450,000	Stk.	Feb. 4	74/4	4	Do. 4 p.c. Red. Deb. ...	100—103*	...	...
6,709,895	,,	Feb. 4	5	6½	South Met. Ord.	135—140*	−2	135—139
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf. ...	150—155*	...	153
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf. ...	106—109*	...	...
1,895,445	,,	Dec. 17	3	3	Do. 3 p.c. Deb. ...	91—94	...	91—93½
1,000,000	,,	Jan. 7	5	5	Do. 5 p.c. Red. Deb....	118—121	...	...
209,820	,,	Aug. 13	8½	8½	South Shields Con.	186—188*d*	...	...
1,543,795	,,	July 9	6	6	South Suburban Ord 5 p.c. ...	145—150	...	146—147½
512,825	,,	,,	5	5	Do. 5 p.c. Pref. ...	124—129	...	126—129½
500,000	,,	,,	4	4	Do. 4 p.c. Pref. ...	108—111	+2	110½
868,837	,,	Dec. 17	5	5	Do. 5 p.c. Deb. ...	129—134	...	133
250,000	,,	,,	4	4	Do. 4 p.c. Deb. ...	108—111	...	110½
647,740	,,	Feb. 4	5	5	Southampt'n Ord. 5 p.c. max.	116—121*	...	...
121,275	,,	Dec. 17	4	4	Do. 4 p.c. Deb.	102—107	...	...
350,000	,,	Feb. 4	5½	5½	Swansea 5½ p.c. Red. Pref. ...	113—118*	...	117½
200,000	,,	Dec. 17	6½	6½	Do. 6½ p.c. Red. Deb. ...	100—105	...	...
1,076,490	,,	Aug. 13	6¾	6¾	Tottenham and District Ord.	165—170	...	168—169
409,835	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	133—138	...	...
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	122—127	...	126
199,005	,,	Dec. 3	4	4	Do. 4 p.c. Deb. ...	102—107	...	...
369,774	,,	Feb. 4	7	7	Uxbridge, &c., 5 p.c.	166—171*	...	169—171
108,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	122—127*	...	124—124½
1,326,700	,,	Feb. 4	7	7	Wandsworth Consolidated ...	167—172*	...	168—169½
1,371,373	,,	,,	5	5	Do. 5 p.c. Pref; ...	125—130*	...	126½
1,317,964	,,	Dec. 17	5	5	Do. 5 p.c. Deb. ...	132—137	...	134—135½
208,300	,,	,,	26/8	4	Do. 4 p.c. Deb. ...	108—113	...	...
158,400	,,	Aug. 13	6*g*	5	Winchester W.& G. 5 p.c. Con.	120—125	...	...

Quotations at :—*a*.—Bristol. *b*.—Liverpool. *c*.—Nottingham. *d*.—Newcastle. *e*.—Sheffield. *f*.—The quotation is per £1 of stock. *g*.—Paid £3, including 10s. on account of back dividends. * Ex. div. † Paid free of income-tax. ‡ For year.

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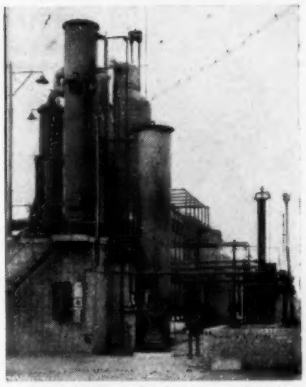
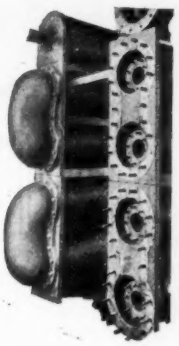


Actual photograph of "Permac" joints in an important London Gas Works.



"Permac" joints, Steam and Benzol Pipes on a Benzol Super Heater Coke Oven By-Product Plant.

Here are further examples of "Permac" joints. Engineers everywhere are realising that a metal-to-metal joint is far superior to sheet jointing, and are therefore increasingly demanding "Permac."

A "Permac" joint stands up to all temperatures and pressures, and being rustless can easily be broken down when necessary. "Permac" is equally suitable for gas, water, steam, or oil.

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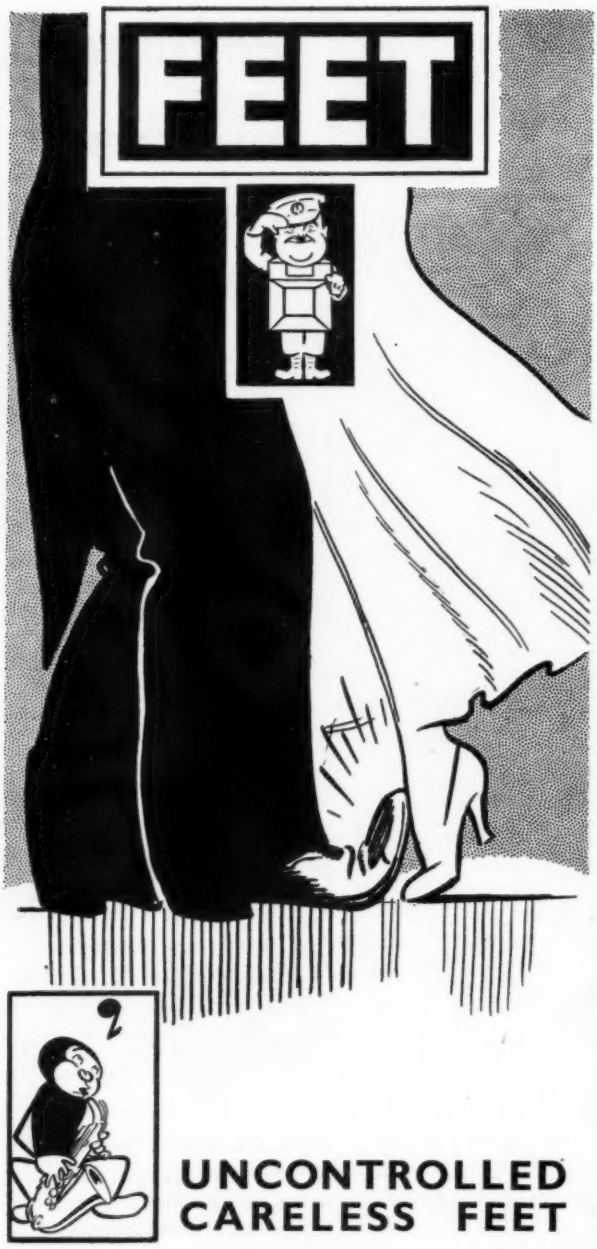

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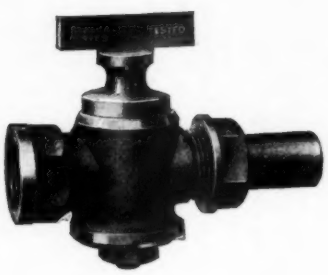

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